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Vol. 14 **No. 3**

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ARTICLES

AUSTRALIA'S SPECIAL INTEREST IN PLANT INTRODUCTION

By PROFESSOR J. A. PRESCOTT

If one is prepared to learn, one of the most important advantages of a visit to overseas countries is the new sense of perspective with which Australia's own problems can be viewed on returning. The recent visit to India by the Australian Scientific Delegation and Goodwill Mission was refreshing to an agriculturist in that one met people with different senses of values and saw an old-established system of agriculture with an extensive range of crops. Although we are conscious of the fact that all Australia's crops and domestic animals are of overseas origin such a visit proved a forceful reminder of this and was suggestive of a number of implications.

The scientific workers in India have not been slow to recognise the value of their material and have developed schools of economic botany and cytology leading to noteworthy plant breeding achievements.

Characteristic of this wealth of material were the collection and description of types of cassava at Trivandrum, collections of sugarcane and bananas and of respective related species at Coimbatore, the recognition of the large number of types of rice, said to be four to five thousand in number, and the collection of polyploid hybrid Brassicas at Lyallpur.

When Australia was first discovered and later colonised no plants or animals of economic importance apart from the native trees and grasses were present in the country. The aboriginal inhabitants were unfamiliar with agriculture and organised pastoral activity. Nor did the native plants and animals lend themselves to domestication.

The absence of a land route to the continent isolated the aboriginal population and meant that no opportunities existed for the exchange of cultures, however primitive, with other peoples.

America's Contribution

This was in marked contrast with what happened when the American continent was discovered. There agriculture was already developed although domestic animals were few and unfamiliar. The wealth of new agricultural material that the new world gave to the old must have played an important part in raising the standard of living in Western Europe in the fifteenth and sixteenth centuries. It is only necessary to recall some of the contributions made to old world agriculture by the Americas to emphasize their importance. Maize, potatoes, tobacco, cacao, tomatoes, the larger phaseolus beans and the peanut were amongst these new contributions. Some of these, such as the potato, reached Europe early. Some of the beans reached Africa with the slave trade. Others, such as the tomato, did not become widely known until towards the end of the nineteenth century.

The traffic was not, however, in one direction, and the early pioneers in America took with them the crops with which they were familiar. In due course this introduction became more systematised and led to the plant introduction and exploration services, particularly of the United States Department of Agriculture and in a reciprocal direction of the Russian workers in Applied Botany.

Gain to Australia

Australia therefore, more than any other continent, stands to gain by the introduction of plants of likely economic importance. It was natural that the early settlements should have tried the more familiar plants of temperate and tropical regions. On the early farms at Parramatta in the 1790's were grown maize, wheat, barley, oats, potatoes, vines, turnips and grain sorghum (as "caffre-corn" from the Cape of Good Hope). The first ships to reach Sydney brought with them coffee plants and seed, cotton seed, and plants of banana, guava and tamarind and before long an orchard including grape vines, and fig, orange, pear and apple trees had been established. This was paralleled in all the colonies as they developed.

As the climate became more thoroughly understood more attention was given to local types such as wheats from North Africa and as plant hybridisation began with the work of Farrer to the introduction of material primarily for breeding purposes. The introduction of ornamental and shade plants, particularly of exotic trees also proceeded early and amongst these importations the Monterey pine from California subsequently proved to have silvicultural possibilities undreamt of in its native habitat.

Many plants, particularly of forage value and some weeds were introduced as seeds in hay imported for the feeding of stock either in the early years or under the stress of drought subsequently. In such accidental importations no doubt came subterranean clover, possibly the first really original agricultural plant developed in Australia.

That the field for introduction even from the temperate and subtropical regions is not exhausted is illustrated by recent experience with flax and linseed, safflower and rye corn while the possibilities for tropical introductions are still very considerable.

The new outlook should not only be the search for plants and seeds which will automatically find a place in Australian agriculture but primarily for breeding material so that new varieties appropriate to the local Australian environment may be developed here.

As part of this we need to know much more about the cytogenetics of our introduced material as well as of our native Australian material. In other words we should possibly be consciously introducing genes rather than varieties.

Parallel to this introduction work there is need for physiological work on the growth responses of plants to temperature so that the types of plants appropriate to various environments may be more thoroughly appreciated.

Climatological Factors.

The climatological side has also to be considered. Among the climatic considerations are the length of the rainfall season and its reliability, factors which are to be linked with drought resistance and earliness in crop plants. Atmospheric humidity is known to play a part in seed setting in some crops and probably in quality control in tobacco. A knowledge of the march of temperature throughout the year is important in establishing in Australia homoclimes of the native habitats of exotic perennial species.

In addition there are the well-known photoperiodic effects and possibly thermoperiodic ones as well.

Agricultural climatology in Australia should naturally concern itself with some of these problems and try to improve its concepts and methods in order to meet this need.

Edaphic factors may also prove to be important in determining the success or otherwise of introduced plants and should not be overlooked.

Australia then stands much to gain by continuing her efforts in the field of plant introduction and in the related fields of plant physiology, climatology and edaphic adaptation.

NOMENCLATURE AND SOIL SCIENCE

By R. SMITH

Introduction

One of the most characteristic features of science is its technical jargon. Technical terms in great variety are used freely in the conversations and writings of the modern scientist, and the student of science should master the intricacies of terminology in a systematic, rather than an empirical, way.

Scientific terms are the result of conscious word building on a considerable scale. Contributions have come from many different sources, for science and scientific terms are international. The oldest branches of science, in general, are those with the most complete systems of terminology. In the more recently developed fields of science, on the other hand, the terminology is often of a provisional nature and provides inadequate reference to the processes or things described. The precise and comprehensive botanical and chemical systems of nomenclature, for example, contrast sharply with the incomplete and often ambiguous system used in the new science of Pedology. It is the purpose of this paper to present a working knowledge of pedological nomenclature to those scientists with only a secondary interest in soils, and at the same time to suggest a number of fairly obvious improvements to the system.

Pedological Nomenclature

It is characteristic of Pedology that its terminology reflects the long and close association between agriculture and soils. Vernacular terms used by the farmers of many different nations are found in the literature, together with the synthetic products of conscious word building. The glossary of "Soils and Men" (1938) gives a list of several hundred pedological terms, a randomized selection from which is sufficient to show their heterogeneous origin.

The vernacular of the Russian peasant is well represented by such well-known expressions as podsol, chernozem and solonetz. There is no exact translation for such expressions. We are told that podsol means "just like ashes" and refers to the ash gray sub-surface horizon of the grey forest soils of European Russia. In a similar way chernozem and solonetz refer to the peasant conception of the intrinsic properties of the black soils and salty soils respectively that occur in southern Russia. The word rendzina is a Polish peasant expression of similar origin which refers to the agricultural characteristics of shallow black soils formed over marls and soft limestones. A series of vernacular Scandinavian words, mor, duff and mull, is used to describe different kinds of soil organic matter. There is also a considerable number of words such as sand, silt, clay, which have been taken from the vernacular of the English-speaking farmer. These terms of vernacular origin are found alongside such words as pedocal, catena, fasc, which are the result of conscious word building from Greek and Latin roots.

Efficiency of Terminology

It is pertinent to ask ourselves at this stage how efficiently does such a heterogeneous assemblage of expressions serve its purpose? Can the systems, processes

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and things which make up Pedology be adequately described by such nomenclature? The answer is, I think, that the system does work but not very efficiently. Much of the weakness arises from the lack of definition in the vernacular expressions which have been forced into a service where preciseness is required. With peasant expressions that are not easily translated into other languages this is a serious difficulty. The wide application of the Russian word podsol to soils of Europe, Asia, America, Africa and Australia has given rise to a number of inconsistencies. The American use of the expression "red and yellow podsolic soils," for example, has been roundly criticised in certain quarters which regard red colours as being incompatible with the characteristics of the podsol profile.

Confusion has also arisen in the widespread application of the terms chernozem, rendzina and solonetz. Even where expressions can be accurately translated from one language to another, difficulties in usage may still be expected. Students of soil science are all familiar with the confusion that has arisen over the Russian term "chestnut soils" which Glinka (1914) used in describing soils of the semi-arid regions of Russia and Turkestan. English-speaking peoples immediately regarded these soils as being reddish-brown in colour and the Americans described certain brown soils of the semi-arid United States as chestnut soils and reddish chestnut soils. Later news from Russia, however, disclosed that the chestnut soils of Russia were gunmetal grey in colour.

Further difficulties arise in the use of vernacular expressions which are made to serve a scientific as well as vernacular purpose. There are many examples of such words taken from English, e.g., series, type, phase, association, muck, profile, sand, silt and clay. For these expressions to be used effectively close definition and control is necessary. Such precision has been attained with the expression, soil profile, which is an admirable example of how a vernacular expression can be shaped for scientific use. Other expressions are less exact, however. The bracket of terms, sand, loam, silt and clay present a special case of vernacular expressions which are overworked. Besides their vernacular meaning these terms are used technically in two distinct ways, firstly, to describe soil texture and secondly, to describe the size limits of the mineral soil particles.

How may these deficiencies in pedological nomenclature be rectified? One of the most pressing needs is for accurate definition and close control in the use of vernacular expressions already in use. That this is possible, is shown by the shaping of the term, soil profile. There is need for new expressions in the case where one term is used to describe more than one distinct process or thing. New expressions are also required to describe processes or things for which, at present, there is no technical term. The synthesis of such terms by word building from Greek and Latin roots seems the only solution to this problem. The currency of such precisely defined terms as pedology, pedalfer, pedocal, catena and fasc vouches for the success of such a system. Classical Greek which abounds in compounds and words with derivatives affixes, can provide sufficient material for all of Pedology's requirements. The method of compiling words from this source is well known to botanists and biologists, who do not allow their sciences to stagnate because of lack of suitable words. I believe, that the shaping of a satisfactory system of nomenclature, is one of the most pressing needs of Pedology and one which should be tackled at once by a representative committee. Some aspects of this problem are set out below.

The Scope of Pedology

A definition of Pedology is given in "Soils and Men" (1938). Pedology is defined as "The science that treats of soil:

i.e., soil science. *Pedo* is from the Greek word for ground or earth. The term is used commonly for the more fundamental aspects of soil science, whereas the term agrology is used sometimes for the applied phases of the subject. In the United States, the term agronomy is used frequently to cover the applied phases of both soil and science and the several plant sciences dealing with crops. This use of agronomy is so broad as to be somewhat confusing, however, and more and more this term is being confined to the applied phases of the plant sciences dealing with crops. The term edaphology has been used by some as an approximate equivalent to soil science and by others to cover plant-soil relationships. Although it is not widely used, one of its derivatives, edaphic, is used by ecologists as a general term for soil influences or conditions."

Pedology can be conveniently separated into two parts, firstly, the study of soil materials or constituents, and secondly, the study of soil individuals or soil profiles. The study of soil constituents, which is at present nameless, is concerned with the study of soil as a three-phase system consisting of solid, liquid and gaseous material. This field of study, which is carried out principally by laboratory workers, is variously labelled soil physics, soil chemistry, soil mechanics, and soil microbiology. The outlook in this field is that of the 19th century agricultural chemist who regarded the study of the soil as a branch of applied chemistry.

Soil Profiles.

The study of soil profiles is also nameless. I suggest, however, that a fitting name for this field of endeavour is *Pedography*. The distribution of soil profiles has been widely studied and a number of important world group such as podsols and chernozems have been recognised. The characterisation of such groups provides a sound basis for the development of a world system of soil classification; we are, however, some way from the attainment of such a system because of the incompleteness of our knowledge of the soils of the world. Maps showing the distribution of soils over continental areas have been prepared by a number of workers; the mapping units chosen in each case have been taxonomic units:—podsols, chernozems, etc. This choice of units is unfortunate because the broad soil patterns or associations of continental areas are generally compounded of more than one taxonomic group. The compilers of such maps generally overcome this difficulty by stating that they are mapping the "normal" or "zonal" soils of the continent. This compounding of taxonomy and soil geography which also occurs in many text books leads to a good deal of confusion in the minds of students.

The formation of soil profiles is known as Pedogenesis; the factors in soil formation are climate, vegetation (more broadly the biotic factor), relief, age and parent rock. Various processes involved in soil formation have been recognized and the better-known processes such as podsolization, calcification, gley formation, pan formation, salinization and desalinization have been described in some detail. The soil profile is the end point which gives expression to the factors and processes which have contributed to its formation.

This is Pedology as I see it, with a deficient system of nomenclature as its major problem. I feel that the discussion which this article may provoke will react to the benefit of Pedology.

(*Received for publication, 12th August,* 1948.)

NATIVE AGRICULTURE IN NEW GUINEA

By D. O. ATHERTON

The most striking difference between the native agriculture of New Guinea and agriculture as we know it is that in the former, almost the whole of the effort is directed towards the production of essential foodstuffs for local consumption; there is very little which is regarded as surplus and therefore available for "trade" or consumption at a distance. The principal aim then, and in most cases the sole aim of the native agriculturist, is to produce food for the family or others in the village community.

The Diet

The people of New Guinea could never by any stretch of the imagination be called gourmands. There is a sickening soul-searing sameness about their food that would send the average European crazy within a few weeks. The staple is always some locally grown carbohydrate-rich material such as sago, sweet potato, bananas, yams, taro, etc. Numerous subsidiary materials are used but the quantities are always small and the availability spasmodic except for the coconut, which is made very good use of by the coastal natives. The most striking and the most constant dietary deficiency is in the matter of protein, particularly animal protein, although salt runs it a close second. Salt is, of course, readily available to the natives on the coast, but must be sweated for, fought for, or longed for by everyone else.

Under natural, or pre-European, conditions there was very little contact between coastal natives and the hill peoples and as a result common salt was in very short supply in the hills. At a few places in the highlands salt springs occur and provide a source for the local inhabitants. Small bundles of special types of local grasses or reeds are soaked in the salt water and afterwards dried out and burned. The ash contains a fairly high proportion of salt and is used as an article of barter. As an indication of the value placed on salt by the hill people it may be mentioned that on one occasion a number of villagers carried packs weighing up to 40 lb. each for four hours over mountain trails and considered themselves amply rewarded when given a couple of ounces of salt each. Each lot of salt was very carefully wrapped in banana leaves, made up into a small bundle complete with handle and borne back in triumph to the home village.

Protein Supply

Before passing on to a consideration of the actual cultivation of crops, it may be of interest to touch briefly on native attempts to obtain proteins of animal origin. Domestic animals supply our animal proteins of course, but such animals are not used very much by the motumen. They have no cattle, no horses, no sheep and no goats but they do have a few pigs and fowls. These are not as valuable in the diet as might be supposed; the pigs, for instance, are far too precious to be killed for food, except on the most special occasions. The usual conception is that a man is as wealthy as the number of his pigs and even wives may be rated at so many pigs. No effort is

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The writer had opportunities of seeing much of New Guinea and Papua during the recent war, firstly, as an officer in charge of an A.I.F. mobile research unit, and then later as Assistant Director of Agriculture with A.N.G.A.U. The agricultural observations made, however, were not co-ordinated and the notes recorded here are more random impressions than dovetailing parts of a panorama of New Guinea agriculture.

made to house and feed these animals, and, although fences are much in evidence in and about the villages, they are constructed to keep the pigs out, not in. The result is that the pigs are the village scavengers and they certainly look it! The only fat pigs seen lived near a rice mill in the Mekeo country where they feasted on the mill offal. There was nothing to indicate that the poultry was looked after any better than the pigs and in the villages they added very little to the diet of the people.

The diet is supplemented to some extent by the produce of the chase, both on land and in the water. Wild pigs and crocodiles are hunted with some success and cassowaries make welcome additions to the bag. Gouria pigeons, which may weight up to 6 lb. each, and other water fowls occur. In the "dry" season the "Kunai" is sometimes fired, so exposing tasty game such as wallabies and small rodents.

Fishing

Fishing and prawning provide the coastal people with some additional food. Lines and nets are used and the macerated roots of derris, called "New Guinea dynamite" by the Papuans, are very effective in small bodies of water. The species of derris in common use on the coast could not be identified definitely, but it may be *Derris uliginosa*. The plant is widely dispersed on the South coast at least, but it is unusual for more than an odd plant or two to be found in any one village. At Lalapipi, for instance, a village of some 250 inhabitants, there was but a single plant, although it was spread over an area of some eight to ten square yards. When roots were required the sandy soil about the base of the plant was dug until sufficient roots were exposed. The size of the roots most favoured for fishing are from one-eighth to three-sixteenths of an inch in diameter. The method is to hold a small bundle of roots, perhaps three to four inches long by half an inch in diameter, on a short hard stick in the left hand and to macerate by tapping with another smaller stick in the other hand. After crushing in this manner water is allowed to run over the roots and fall back into the pool in the vicinity of the fish. The effect on the fish is sudden, and stupefied fish, maybe up to two pounds in weight, come to the surface five minutes or so after the water is impregnated with this crude extract. Incidentally, the people discard nothing in the shape of a fish, whatever may be the size; fish as small as an inch or two in length are made just as welcome as the bigger game.

Native Agriculture

Despite the occasional yields from the hunting and fishing activities the gardens are the principal source of food, and they are part and parcel of every village community. It is very difficult to express an opinion regarding the size of an average garden but many seen were somewhere around a quarter of an acre in extent. The garden is constructed—at a colossal expenditure of labour — fenced and planted, thus assuring the family of a good supply of food for *one* year or perhaps a year and a half. After a year or so the weeds and grasses and even the shrubby undergrowth are so all-embracing that the garden must be abandoned. Before the old garden is quite finished a fresh piece of land is cleared, burned off, fenced and planted as before; rain forest or jungle for some years, crops for a year or two, then back to the jungle is the the fundamental rotation. The number of years under jungle depends on the population of the tribe and the extent of its lands. In some areas it may be as long as fifteen years between crops, in others as short as three, or even less. Circumstances beyond the control of the natives may lead to a reduction in the rotation time, as on the island of Kiriwini in the Tobriands during the war. There a considerable area was occupied

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by Allied troops and a large airfield, and the amount of cultivable land left to the natives was so restricted that gardens had to be re-established on land which had borne crops only two years before. The result was an obvious reduction in fertility and increased pests and diseases.

Advance of grass into the jungle

In almost all parts of New Guinea there is always the likelihood of the rotation being broken by the reclamation of the garden by grass instead of jungle. The native agriculturists cannot cope with the grass and the area passes out of cultivation, although the impression was gained that the jungle would push back the grasslands providing no extraneous influences were at work. However, the practice of firing the grass for small game, allied with the shifting agriculture has so upset the natural balance that "Kunai" now covers thousands of acres of hills and flats. It may be mentioned here that "Kunai" is a general term applied to a dense stand of any large grass such as blady grass (*Imperata arundinacea*), *Themeda* or native sorghum. The area of kunai is increasing year by year as the recurrent grass fires kill back the edge of the jungle. One observer at the head of the Ramu River reported that several thousand acres of jungle had been invaded by grasses in a period of only five years. The same sort of thing can be seen in North Queensland where, during the last twenty to thirty years, blady grass, with the aid of annual fires, has covered the ranges from sea level to 2,000 feet. The obvious result of the encroachment of the grass in New Guinea is that the natives are, in many areas, desperately short of land.

The Garden

The first operation, of course, in the preparation of the garden is the felling of the jungle trees and it is hard work with the small axes which are the only tools available. It is interesting to note in passing that heavy axes are the exception in native villages; the most favoured implement being a small head of approximately two and a half pounds on a straight, black-palm handle, three to four feet in length. After the felling and drying out, the jungle is fired and as many as possible of the branches and boles heaped together for burning. There is no attempt to remove the stumps and roots and the crops are planted without any further preparation. The usual practice with most crop plants is to set the cuttings, etc., in small holes dug with a pointed stick. The size of the trees in the patch of jungle to be felled for a new garden naturally varies with the time since that particular patch of ground was last under cultivation.

The protection of the garden from animals is essential. In most parts of New Guinea this means, in effect, protection from pigs, both of the village and wild types, although in some districts the few cattle and goats can be a menace. The protection of the gardens from these larger animals is effected by the erection of a palisade fence, which involves a tremendous amount of work, even though the sticks are not sunk in the ground but are held upright by cross pieces tied from tree to tree.

In most cases the gardens are given no protection against the attacks of insects and rodents, although an exception was observed on Manus Island. There a homopterous pest of taro sometimes occurs in epidemic numbers and the natives then flail the food plants with large twigs taken from a special kind of local tree. Some significance appears to be attached to the use of this particular tree, but whether there is any justification for this belief or not, could not be checked. The beneficial results obtained from this practice may be explained by the fact that the nymphal stages of the pest have some difficulty in regaining the leaves when shaken to the ground and are possibly attacked by ants and other scavengers.

The selection of tools available to the native agriculturist does not extend beyond small axes, hoop-iron knives and pointed sticks, and the maintenence of the garden is therefore very difficult. No cultivation of the ground is practised and the only implement used for the control of weeds is some form of long handled knife. It may be a rather heavy bladed machete or a piece of hoop iron, perhaps three feet long, with a piece of material bound around one end to serve as a handle. The weeds are slashed off at or near ground level.

THE MORE IMPORTANT CROPS

It would be extremely difficult to set out a complete list of all crops cultivated on the Islands and all that will be attempted here are brief notes on those actually seen in cultivation.

The Coconut

This is, of course, the most characteristic crop of the tropics; one can scarcely imagine a tropical island without its fringe of palms. There is a definite association with the ocean and on the large island of New Guinea there are few plantations at any great distance from the coast or at any considerable elevation. One further point of interest in connection with this crop is the occurrence of a particular type of coconut in the villages of the Markham Valley. These nuts are very large—being one to two inches greater in diameter than the ordinary type—and with a thick kernel and thin shell they contain about twice as much "meat."

The diversity of uses to which the coconut is put are legion. The people who have access to them seldom drink water; the usual practice for anyone wanting a drink is to climb a palm and knock down a few immature nuts. The end of the fruit which was attached to the tree is split, the nut held in the air and the juice allowed to run down the throat. The lips are not placed in contact with the fruit and the spilt juice does not add to the elegance of the drinker!

The kernel or meat of the riper nuts is used very widely as food, and in many cases is the main source of protein in the diet. It is quite usual for the meat to be grated into the mass of taro, yams or other root crops before cooking. Since the oil is not removed, the characteristic, rancid smell of coconut oil associated with the local people is quite as likely to be internal in origin as external. However, the oil is extracted at times, using crude methods of maceration, expression and clarification of the juice in water. Ripe coconuts not used for human consumption are eaten by pigs, and it is remarkable that these animals are able to dehusk and break into the kernel of the nut.

The nut is by no means the only part of the plant used by the local people. Even on the coast where the foliage of the "nipa" palm is usually available for roofing, coconut palm leaves are often used to form the ridge capping of the huts. The midribs of the coconut leaflets are used by the children as arrows and although regarded as toys, are quite effective in bringing down small birds or shooting lizards and fish. The coconut matting at the junction of the leaf and trunk in the head of the palm is also useful, particularly as a sieve for the separation of the macerated pith of the sago palm from the starch.

The coconut trees belonging to the inhabitants of a village are usually scattered in a most haphazard manner. It appears that when a villager dies a small memorial garden is established and protected by a pig-proof fence. This garden would not be more than thirty feet square at the most and in it flowers, ornamental shrubs and a few coconuts are planted. In time the garden is neglected, the fence disappears, but the palms survive. It appeared that this was one of the most important ways in which the supply of coconuts was maintained.

The Banana

This food plant has an extremely wide distribution in New Guinea, as in other Pacific Islands. The plant is cultivated in native gardens, at least up to the 7,000 feet level. There is a wide diversity of types in the bananas grown. In some areas short plants resembling the Cavendish were observed, but most of the gardens contained taller plants, with stools 20 feet in height not uncommon. Very large bananas of the plantain type occur in some villages, notably at Onga in the Markham Valley, but the most common size approximated that of the Queensland Lady Finger.

Ripe bananas are apparently not eaten by the natives, who roast fully grown, but obviously unripe, fruit in the coals. The result is quite pleasant to eat. Several attempts made by the author to ripen what appeared to be fully grown fruit were unsuccessful and some types were quite unattractive in the raw state even when they appeared to be ripe.

Sweet Potatoes

This crop was grown in most of the villages seen although it is far more important in the highlands than on the coast. In one highland area it appeared that about 90 per cent. of the food consisted of sweet potatoes and it is on record that the necessary ration for working boys was of the order of 15 lb. per day. This is a colossal bulk of food, but it was apparently essential in a diet so deficient in other essentials.

The crop is planted from short runners and hilled rows are not in general use. The most common method of planting is to erect small mounds about two feet in diameter and a foot high, and plant two or three cuttings on the top. This method simplifies weeding and minimises waterlogging. In some parts of the highlands the crop is grown on graded terraces, and irrigated from mountain streams.

Yams, Taro and Cassava

These can be treated under the one heading here since they are all usually grown in the villages, although yams and taro would be more widely used than the cassava. It appears that a little cassava is planted as a general practice, but that it is not often required and is kept merely as a standby in case of failure in the others. Edible taros root usually weigh about four to eight pounds, but yams are much larger and specimens weighing one cwt. were seen.

Sago

Sago is the principal standby of the coastal people, particularly those of the delta regions of the Fly River and for several hundred miles eastwards. The plant does not appear to be cultivated in gardens, probably because it would not be possible to make a garden in the localities most suitable for this palm. It grows in very swampy areas, usually where the water is permanently between one and two feet in depth. The collection of the sago is a picnic day for the whole village. Usually the trip commences in canoes but finishes as a struggle through a tangled mass of very spiny sago leaf butts and debris from old trees, all mixed with mud and rubbish.

Sago palm forests often occur as nearly pure stands, composed of plants of all ages from suckers to full maturity. The method of natural propagation is by slips or suckers and maturity is indicated by the appearance of an enormous inflorescence from the crown. It may be up to twenty feet in height and fifteen in diameter and although maturity may be reached in fourteen years under very favourable circumstances, it usually takes much longer. The trunk of a mature palm is from 15 to 18 inches in diameter, and has a thin outer shell; it may be 40 feet high. The starchy pith occurs in the trunk and one tree may yield 40 lb. of sago.

The sago is extracted by macerating the pith in a trough and washing out the starch with water. The sago leaf sheath makes a convenient trough about five feet long, which is erected on a temporary stand. One end is blocked with coconut matting and the starch and water run through to a vessel on the ground. The sago is then allowed to settle and the water poured off.

Incidental Food Plants

In addition to the plants mentioned above there are several others which provide some food for the natives. Amongst these is the bread fruit which does not appear to be widely used, although some trees are found in most villages. Papaws grow almost as weeds in patches of newly cleared jungle and the fruit is eaten to some extent. It is usually roasted, probably because if allowed to ripen there would be too big a risk of losing it to pigs or birds or some other competitors. Small lime trees are found in almost every coastal village and the fruit is presumably used to some extent. Sugar cane is found in nearly all gardens and is used directly for food. The fruits of several rain forest trees are also eaten in season.

The Absence of Grain Crops

Although maize is grown as an odd plant or two in most gardens grain crops do not figure in the economy of the people, with the single exception of rice growing in one particular locality. This is in the delta region of the St. Joseph's River, where a District Officer established the crop in the early 1930's. The rice chosen was an upland type and the villagers were encouraged to plant it to the extent of one-quarter to one-half an acre per taxpayer. The idea of the Officer was to accept rice as payment of the poll tax and at the same time get the people to store some for their own use. The crop has not yet become popular with the natives and although they admit to liking boiled rice very much indeed, they object to the labour involved in harvesting and hulling. The harvesting is done by hand, of course, and the grain hulled in a large locally made wooden pestle. The harvesting is usually made the occasion for a carnival; all the young people dress in their finery and sing communal songs as the rice is cut and carted to the village.

The reasons for the virtual absence of grains from village agriculture are fairly obvious. First reason of all is the climate, which shows no winter and virtually no drought, i.e., no period of expected famine against which food has to be stored. Secondly, there is the question of comparative yields—the obvious bulk obtained from crops such sweet potatoes, yams, taro, etc., has much more appeal to the native than the ton or so of grains per acre.

Conclusion

It is very obvious that the New Guinea agriculturists labour under a colossal number of handicaps in spite of their great climatic advantages. They have virtually no tools, no grains, very few domestic animals and have to subsist on a diet which is extremely low in protein.

The ways in which improvements could be effected are all too apparent:—

1. The provision of garden tools and implements.

2. The introduction of staple grains and vegetable proteins, the varieties to depend on the locality.

3. The wider and more effective use of domestic animals for both draught purposes and food.

All will have to be bound up with a general improvement in education in order to achieve their full effectiveness.

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SOME IMPRESSIONS OF AGRICULTURE IN THE UNITED STATES OF AMERICA

By C. J. McKEON

Introduction

Agricultural America* was almost the picture the illustrated magazines have made for us over the years. The season was a bumper, with crop production an all-time record, and farmers were enjoying what was probably the most prosperous period in their history. The amount of modern machinery on the farms, the silos, and the well-kept, solid buildings were evidence of the high prices and unlimited demand for their produce which the war years had brought. The favourable yields of 1946 are shown by some figures for the major crops:—maize, 3,300 million bushels; wheat, 1,550 million bushels; oats, 1,500 million bushels; potatoes, 475 million tons; and barley, 263 million bushels.

To the Australian observer the most striking features of agriculture in America are the high percentage of arable land in the main agricultural States, leading to intensive settlement and the attendant amenities of electricity and good roads, and the extensive hand feeding of stock on the farm. Hand feeding is not confined to the winter months for many farmers feed the whole year round, finding it more profitable to market their produce as beef, pork, poultry and dairy products than as grain or hay. It has been estimated, for instance, that of the average annual maize production of 2,000 million bushels more than 90 per cent. is retained on the farm.

THE SOY BEAN INDUSTRY

Development in the United States

The soy bean has been grown in America for more than 40 years. Records show that 50,000 acres were planted as long ago as 1907, but it is not until recent years that the crop has become of major importance. By 1934, the acreage had increased to 6,000,000 and nine years later it was 16,000,000. This remarkable increase was largely associated with the increased use of the beans, for prior to 1930, soy beans were used chiefly as a forage crop. In 1939, however, the acreage harvested for the beans was forty per cent. of the total and in 1944 it had increased to seventy-two per cent. The development of highly productive strains for the various States has had a marked effect on yields, which have jumped from eleven bushels per acre in 1924 to an average of between eighteen and twenty-one bushels for the last five years, but improved cultural and harvesting methods have also made their contributions. Before headers, or combines, as they are known in America, came into general use for harvesting it was estimated that the loss of beans was often as great as thirty per cent.; the figure with headers is under ten per cent.

Although the acreage for 1946 showed a slight decrease in comparison with that of the previous year, the crop of 196,725,000 bushels was a record.

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**During the latter months of 1946 the writer made an extensive tour of the agricultural areas of the United States and Canada as a member of the committee appointed by the Commonwealth Government to examine the soybean industry. The party was provided with a car, and so was entirely free from the vexatious delays associated with the overburdened public transport. Nearly 16,000 miles were covered during the five months and as well as extensive field inspections, very profitable visits to experiment stations and private farms were also possible.*

Latest available statistics reveal that there are one hundred mills in the United States which specialise in the processing of soy beans. The largest plant is that of the Staley Manufacturing Co., Decatur, Illinois, which has a daily capacity of 50,000 bushels. At the other extreme are several small concerns processing less than 100,000 bushels per year.

Uses

Much has been written regarding the numerous uses to which the crop may be put, but there is no doubt that its use for the production of edible oil, and of meal for stock food offers the only hope for the maintenance of the industry on a permanent basis. According to information obtained from the Soy Bean Regional Laboratory, Peoria, approximately ninety-five per cent. of the oil is used for either shortening, salad oil or margarine. The remainder is used in paints and varnishes or in the manufacture of soap, linoleum and oil cloth. Soy bean oil is inferior to both coconut and cotton seed oils for edible purposes on account of the flavour it develops on being kept for some time. For this reason, it usually sells for about one cent per pound less than cotton seed oil. It is a general opinion, however, that this fault will be overcome, possibly by the application of processes developed commercially by the Germans. Not more than fifteen per cent. of soy bean oil can be used in the manufacture of margarine, since quantities in excess of this amount affect the flavour of the finished product. The oil is regarded as very little inferior to linseed oil for paint purposes, although, owing to its slowness in drying it cannot be used alone. Recent research has shown that it is possible to incorporate synthetic resins with linseed and soy bean oils.

It has been found that for the feeding of stock whole soy beans are not as satisfactory as the meal remaining after the oil has been extracted. Even a limited quantity of the beans will result in soft fat and in the case of dairy cows, soft butter. Research has shown that the efficiency of the protein is greatly increased by heat treatment.

For Feeding Stock

Soy bean meal is rapidly increasing in popularity for the feeding of stock and the 3,444,800 tons of soy bean meal and cake fed in 1943-1944 comprised approximately one-half of the total of all meals fed to stock. The meal compares very favourably with linseed meal as a concentrate for feeding to dairy cows, but in the case of beef cattle results have been conflicting. In some instances the soy meal has been as satisfactory as linseed meal but in others it was not so, possibly due to the method by which the fat was extracted. Meals which give the best results are those which have been heat treated and have a nutty flavour and odour. Experimental work has shown that soy bean rations should be supplemented with lime and phosphorous, as they contain less of these minerals than linseed meal. Most American manufacturers prepare mineralised pellets which have proved quite satisfactory.

There are several other uses for the meal, apart from stock feed, but they utilise only a very small proportion of the meal produced. The most important minor use is for the preparation of excellent quality glues for ply-wood, while smaller amounts are used for moulding compounds, core binder compounds and paper coatings and sizes.

Treatment of Beans

Treatment of the beans is by either the expeller or solvent extraction method, the former being the most extensively used, although within recent years the solvent extraction method is increasing in popularity. The expeller method yields an average of nine pounds of oil and forty-eight pounds of meal; the extraction method approximately ten and one-half pounds of oil and forty-five pounds of meal per hundred pounds of beans. Com-

parable guaranteed analyses of meals extracted by each process are:—

	Expeller	Solvent
	%	%
Minimum protein	41	44
Minimum fat	3.5	0.5
Maximum fibre ..	7	8
Minimum N.Free Extract	29	29

Enquiries revealed that a plant treating from one to one and a half million bushels per annum by the solvent process could be regarded as the economic unit, provided the beans were produced within 150 miles of the plant. A plant of this size, together with storage accommodation for sixty per cent. of the year's intake would cost $1,000,000. A plant of similar capacity using the expeller method would cost $700,000 and would be cheaper to operate, but these advantages would be offset by the increased yield of oil from the solvent plant.

Some attempts have been made to popularise soy bean flour as an article of human consumption, but bakers report that it does not rise as well as wheaten flour and only a small proportion can be incorporated in a loaf. In addition, an objectionable flavour makes the soy flour unpopular despite its recognised high protein and mineral values.

Requirements of the Crop

In all countries in which the soy bean nas been grown extensively it has been found that the plant is very sensitive to soil and climate, and for that reason, a great amount of breeding and selection work has been necessary to suit the particular individual environments. It can be accepted as a general rule that the soil and climatic requirements of the soy bean are the same as for maize since practically the whole of the bean crop is grown in the chief maize growing States. In 1944, eighty-three per cent. of the total acreage harvested for beans was grown in those States and seventy per cent. of the total area sown. The soils in these States are fertile, free-working loams.

In the U.S.A. more importance appears to be attached to the selection of varieties to suit the locality, rather than to the selection of a particular type of soil. However, it is generally accepted that a fairly fertile soil is required, and for preference it should be alkaline in reaction. The rainfall during the growing period, whilst not heavy, is consistent and well distributed in the chief soy bean States. During the growing period of May to September the total rainfall in each of these States is a little under 20 inches, but the precipitation is practically the same in each month.

Cultural requirements and harvesting methods in the U.S.A. are the same as those which have been found satisfactory in Queensland. The rates of seeding, however, are much higher in America, the rate of seeding in rows spaced sufficiently to permit inter-row cultivation is as high as 50 lb. per acre. This heavy seeding would not be possible without the ample and regular rainfall.

Diseases

In the early stages of the industry diseases caused little concern, but with the great expansion of the crop within recent years, some are now reaching serious proportions. Brown stem rot, in particular, has increased and several infected crops were seen which were undoubtedly suffering losses from the disease. Bud blight, downy mildew and halo blight are other diseases which will have to be kept under control.

Some of the diseases mentioned are seed-borne and every care will have to be taken to ensure that introductions of seed to this State are given the necessary curative treatment before sowing.

Effect on Soil

Although one's first reaction to the question "Does the soy bean improve the soil?" would be that it does, reflection may give a different answer, and some

authorities go so far as to state that soy bean crops harvested for grain do not build up soil fertility, nor, surprisingly, do they increase the nitrogen supplies in the soil. This was supposed to be due largely to the fact that the beans were not harvested until all leaves had been shed, and the bulk of these were blown away before they could be incorporated in the soil. Of course, soy bean is a valuable soiling crop when used as such.

Soy beans are often blamed for excess soil erosion in the United States but the reason for this opinion is that they usually follow maize, which means two row crops in succession—a practice condemned by soil conservationists.

Possibilities of Developing the Industry in Queensland

Experimental work conducted by the Queensland Department of Agriculture and Stock over many years has shown that soy beans can be grown successfully in several parts of the State, but lack of suitable markets for the beans has prevented any development of the industry. It is very definite that the successful establishment of the industry here will depend entirely on payable markets being available for both oil and meal; neither alone would be capable of maintaining the industry even at present inflated prices. All other uses would be of minor importance, although the supply of meal for the manufacture of ply-wood glues should be of some assistance. Sufficient is known at the present to initiate field trials on any scale; many farms are equipped with all the machinery required for the production and harvesting of the crop, especially in those districts in which navy beans are grown.

The extent of the market for soy bean oil in Australia is difficult to estimate but it is considered that no difficulty would be experienced in finding a market for large quantities of meal, providing it can be produced at a price to compete with other high protein stock foods. During the 1939-1940 season the Queensland Cotton Board disposed of 4,000 tons of cotton cake for stock. This quantity was not nearly sufficient to meet the demand and was sold within 50 miles of Brisbane.

It is obvious that much breeding and selection work will be necessary in Queensland. One of the chief difficulties to be overcome is the tendency of many varieties to shatter, for it is thought that shattering is more likely to occur in Queensland than in the important producareas in the U.S.A., probably owing to the different climatic conditions. The production of varieties which may be harvested mechanically is also very necessary.

Until such time as it has been demonstrated that the industry can be established on an economic basis under normal conditions it is considered that no large scale planting should be encouraged in Queensland. Steps should, therefore, be taken as soon as possible, to arrange for the production of sufficient beans to enable processing costs to be accurately estimated. It is estimated that 500 tons would be necessary for this purpose.

FODDER CONSERVATION

Fodder conservation is practised on a very extensive scale where severe winters are experienced. It would be the exception to find any farm on which live stock is kept without at least one large tower silo. These are filled each season, chiefly with chaffed maize, which is by far the most popular crop for ensiling. In addition to the silage, large quantities of lucerne and cereal hay are produced and stored in bales. Ensilage harvesters are now used extensively for the handling of silage crops. They cut and chaff the crop and deposit it in box wagons drawn alongside. These are hauled to the silos and a blower transfers the chaffed material to the towers.

Lucerne is one of the most important hay crops in the United States. It is grown

over a surprisingly large area under a very wide range of climatic conditions. Every operation associated with the production of lucerne hay from the cutting to the loading of the baled or loose hay on the lorry, is done mechanically on a very large proportion of the farms. It certainly allows individual growers to produce on a large scale and at a reasonable cost.

The preparation of dehydrated meal from lucerne is quite an industry in certain localities. One particularly fine dehydration plant was seen in operation in the San Joaquin Valley, California. It cost $200,000 to build three years ago, works for nine months of the year, and turns out meal at the rate of four tons per hour. The price of the meal, which has a guaranteed protein content of 17 per cent., is about $54 per short ton. The fresh, chaffed lucerne is brought to the plant and within eight minutes it is in the bag as a fine meal. The chaffed material is first passed through a cylinder nearly one hundred feet long and five feet in diameter, through which air, heated to 1800 deg. F. is drawn at the rate of 40,000 cubic feet per minute. This reduces the moisture content to twenty-five per cent. and it is then elevated to a second, shorter tunnel of at least twice the diameter. Here the moisture is reduced to ten per cent. and the meal then passes through the hammer mill and so to the bag.

Stubble Mulch Cultivation

A demonstration in Nebraska gave an indication of the possibilities of this form of tillage not only for the lessening of soil loss by erosion, but also for the improvement of the physical condition of the soil. The field was carrying a heavy body of wheat stubble, at least eighteen inches in height, and soaking rain just prior to the demonstration rendered conditions far from ideal. Three implements were seen in action, all of the duck-foot type for sub-surface tillage. The first had a single large duck-foot with a cut of five feet three inches; it was drawn by a Fordson tractor and cultivated to a depth of approximately six inches. A rolling coulter was fitted to the point of the foot. The second implement was drawn by a caterpillar tractor and with two feet, each equipped with a coulter, had a cut of nine feet. The third machine had three feet (each thirty-one inches wide) with a cutting width of seven feet. This machine did excellent work and should prove more suitable for the heavier soils than the others. All machines, however, loosened the soil very effectively and at the same time left the whole of the straw on top of the land. Special attachments have been developed to enable corn planters to operate without clogging on the stubble land.

One field was seen which had not been ploughed for sixteen years, all cultivation during that period having been by sub-surface tillage, and crops compared very favourably with those from orthodox methods of tillage.

Grain Sorghum

It was only during the war years that the dwarf grain sorghums which could be mechanically harvested, came into prominence in the United States. This crop is now of considerable importance in Texas, Oklahama, Kansas, Nebraska, New Mexico, Arizona and California. As late as 1941 only ten per cent. of the total grain sorghum acreage was planted to types which could be harvested with a header, but this had increased to ninety per cent. in 1946.

The leading varieties now being grown are Martin, which matures in ninety-five days, Plainsman, maturing in one hundred to one hundred and five days and Caprock, which is very similar to Plainsman, but several days later. The varieties Kalo and Wheatland, which have been grown so widely in Queensland are now grown only to a limited extent in the United States. Hegari, another popular variety here, is still very widely grown in Texas, where a new strain known as

"Early Hegari" has been giving very good results during the past two or three seasons. It is two weeks earlier than Hegari, and like the original variety, is more palatable to stock as a green fodder than most other grain varieties.

Sweet Sudan

This variety is the result of a cross between a sweet sorghum, Leoti, and Sudan grass, and combines the sweet, juicy stalk and sienna glumes of the sorghum with the grassy hardiness of the Sudan There still appears to be some doubt with regard to the poisonous properties of this new variety.

Cotton

Associated with a wide interest in the mechanical harvesting of cotton was the development of so-called stormproof varieties, which hold the cotton firmly even when fully mature, and research into the chemical defoliation of the plants to simplify the harvesting. The defoliating dust is calcium cyanamide and is applied at the rate of thirty pounds per acre. Best results are obtained when the leaves are still moist with dew and remain so for about three hours after dusting. Defoliation is complete in nine or ten days and the still pliable limbs do not break readily when the plants are being stripped by the mechanical harvester.

The latest International Harvester cotton picker was seen under trial in both defoliated and normal crops and performed quite satisfactorily. The quality of cotton from the defoliated crops was higher than from the others owing to the reduced amount of green leaf. These machines are costly but they have performed so well that the demand far exceeds the supply.

Weed Control

Oil Spray

A large vineyard in California with 700 acres under grapes had not used an implement for weed control for seven years. Weed growth had been kept in check by spraying with diesel oil applied at the rate of forty to sixty pounds per acre. The oil costs eight and one-half cents per gallon and with a spray outfit one man can treat thirty acres per day. When spraying was first commenced it was necessary to spray some six or seven times a year but now four sprayings are sufficient. It is claimed that the oil has had no effect whatever on the penetration of water into the soil.

An oil spray is also used extensively for weed control at Riverside Citrus Experiment Station, California, where 400 acres are under cultivation.

Flame Weeder.

None of these machines were seen in operation but a crop of cotton, which had been flamed four times, was quite free from weeds and, in addition, showed an absence of fruiting branches close to the ground—a decided advantage for mechanical picking. A crop of soy beans only seven inches in height was flame treated without harm and it is thought that one or other of the numerous machines might be worth a trial in the maize crops of the Atherton Tableland, where weed growth is a serious problem.

Miscellaneous

It was noted that the bulk of the 90,000,000 acres sown to maize in the United States each year was planted with hybrid seed and that, chiefly due to a very reliable rainfall, average maize yields are high; 40 bushels per acre being quite common over a whole State. It was also noted that, although there are several different types of maize pickers on the market the bulk of the crop is still harvested by hand.

The seed potato-eye trade has been operating for some years in Canada, chiefly as an aid to the transportation of planting material to remote districts; it would not appear to have any application here.

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SUBTERRANEAN CLOVER IN SOUTH WESTERN AUSTRALIA

I. The Place of Subterranean Clover in Pasture Development in the Heavy Rainfall Districts

By H. G. ELLIOT

The area of sown pasture in Western Australia is 2,250,000 acres, of which 2,000,000 or more have a subterranean clover base or were originally sown to this clover. Prior to the rapid development of the use of subterranean clover and superphosphate the area under pasture in 1923 was only 25,000 acres. Most of the other leguminous plants of the higher rainfall areas are confined to relatively small areas and up to the present time there is no legume other than subterranean clover which can be used as a base for our general annual pasture mixtures.

In the high rainfall areas of thirty inches or more per annum the mid-season subterranean clover dominates but early, early mid-season and late varieties are also grown.

In the medium rainfall areas of twenty-two to thirty inches per annum the first early variety of subterranean clover dominates, but early mid-season, mid-season, and in some instances, late varieties, are grown also but under selected conditions.

Varieties Grown

The known varieties of subterranean clover are numerous but only five are grown commercially in this State and of these the Dwalganup First Early and Mt. Barker Mid-Season predominate. The five varieties grown are:—

1. The First Early.
2. Yarloop White seeded.
3. Bacchus Marsh.
4. Mid-season.
5. Talarook Late.

Subterranean clover has a wide range of soil types in which it will grow, ranging from good medium sandy loams to heavy clay or light sandy soils and ironstone gravel country.

Establishment

Methods of clearing in preparation for and establishment of subterranean clover are many and varied. It is well known that in its virgin state the fertility of our land is low but the ease with which subterranean clover is able to establish itself on virgin soils is of great importance to pasture production. Once established this clover rapidly builds up the fertility of the soil by increasing the nitrogen status which enables the introduction of a good grass association to take place. The most outstanding annual grass for this association is Wimmera Rye Grass, although perennial types may also be successful.

A symposium entitled "Some Aspects of South-West Agriculture," was presented at the June meeting of the Western Australian Branch of the Institute.

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Subterranean clover, apart from its valuable use in the initial development of land, still remains the dominant legume base for our annual permanent pastures.

Establishment commencing with the actual seeding and subsequent grazing management varies considerably and many factors, including climatic and soil types, have to be considered. Inoculation is necessary when establishing subterranean clover and certified seed should always be used. The rate of seeding varies according to districts and soils and also the cost of seed, as higher rates of seeding can be economically employed when the cost of seed is relatively low.

Fertilizer Requirements

Superphosphate is necessary on all our soils. Without it subterranean clover will not produce well and on new land it will not establish itself readily. Superphosphate should be sown at the time of seeding, the rates varying from one and a half hundredweights to three hundredweights per acre and with respect to topdressing in the higher rainfall areas the most economical yields are obtained from one autumn application of two hundredweights of superphosphate per acre.

Micro element deficiencies such as copper and zinc have occurred in various localities. In this State copper deficiencies have caused complete stalling of the clover, and by the addition of a copper containing mineral to the superphosphate and the re-seeding of the completely stalled areas, excellent regeneration of the clover has occurred.

Apart from subterranean clover being the basis of our pastures for foodstuff for our dairying, and to a large degree meat and wool industries, the export of subterranean clover seed from this State has become quite a large and profitable industry.

II. The Significance of Subterranean Clover in the Wheatbelt

By F. L. SHIER

Reference will be made to the cereal areas or that part of the agricultural areas experiencing an annual rainfall of up to approximately twenty-two inches, and emphasisis will be placed on the association of subterranean clover with cereal production and its probable influence in the future pattern of wheatbelt agriculture.

Although land utilization in the past has been concentrated mainly on the better soil types, future development will consist of utilizing the light lands of which perhaps ten million acres of the better types are still undeveloped. The past development of such soil types has not been very successful due mainly to their low inherent fertility and lack of natural legumes. A good legume in the rotation is essential for their successful development. Also, although the inherent fertility of the heavier soil types is higher, nevertheless this fertility must be maintained and not depleted.

Numerous legumes have been tried but the most important development is that subterranean clover, despite a number of disabilities, has completely changed the outlook for the medium textured soils under review and will help render possible the successful development of perhaps a further ten million acres of light soils.

Limiting Factors

In the determination of the limits of subterranean clover soil type is a factor at least as equally important as rainfall as it persists on light and medium textured soils with less rainfall than needed for its persistence on the heavier soil types.

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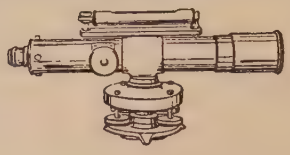

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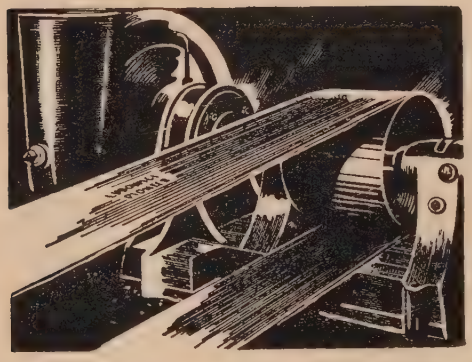

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With the establishment of some two thousand acres of Dwalganup subterranean clover at the Wongan Hills Research Station two important points have become apparent which have a bearing on the ultimate limits of expansion of subterranean clover.

Firstly, it commences to flower and produce seed very early—late July and early August. At this Station, in 1939 and 1940, with less than seven and a half inches of rain in the growing period and practically none in August, September and October the clover planted matured seed and persisted.

Secondly, it has a greater inherent capacity to produce a large bulk of herbage than the so-called native clovers such as cluster and hop clover.

Its ability to produce some seed even in very dry years and to thrive abundantly when conditions are good has a very important bearing on its Eastern limits as a valuable pasture plant and on its ability in suitable soil types to ensure sound agriculture.

The increase in carrying capacity and crop yields through subterranean clover, though never accurately measured, are, however, very definite, and to obtain precise data a large-scale experiment has been commenced at the Wongan Hills Research Station in association with the Council for Scientific and Industrial Research and Institute of Agriculture.

Effect on Wheat Quality

Another important aspect is to its effect on wheat quality. Wheat grown on light soils produces flour which is low in strength and is unsuitable for making good quality bread. Climate and soil have an important bearing on wheat quality and it has now been shown that factors in flour which made for good bread are definitely improved where the wheat has been grown on land following legumes.

Summarising then, early subterranean clover is likely to be responsible for considerable change in the pattern of wheatbelt agriculture in this State during the next few decades. Through its use it should be possible to rehabilitate and increase the carrying capacity and crop yields of much of the medium class soils now under cultivation, wheat production in the westerly districts should tend to rise following better yields per acre, it will help to render possible the development of perhaps a further ten million acres of light land, whilst the overall quality of the State's wheat should improve following better quality wheat from light lands when this clover has been incorporated in crop rotations.

III. Subterranean Clover in Relation to Soil Erosion

By L. C. LIGHTFOOT

The establishment of soil cover preferably in the form of pasture, is the simplest and most economical method of preventing soil erosion and of reclaiming soils on which erosion has already commenced.

Evidence of erosion is widespread in Western Australia where most of the damage has occurred in the fifteen to twenty inches rainfall zone. At present comparatively little of the erosion damage may be classed as severe, but once erosion has commenced the severity of the damage quickly increases. As soil conservation practices are more effective and less costly if adopted before serious erosion occurs the need for a vigorous soil conservation policy in W.A. is obvious and subterranean clover pastures have frequently prevented and arrested soil erosion in this State.

Water Erosion.

The far-reaching effects of raindrops falling on bare soil are not fully realised by farmers and others, especially when the base soil is covered by a thin sheet of water and more particularly on sloping land. One effect of raindrops battering on bare soil is to produce a surface seal by flooding small particles into the crevices between the larger ones as the soil absorbs water.

On sloping land water not absorbed where it falls tends to accumulate in hollows and run downhill. Concentration of water soon gives it power to scour channels and carry the eroded soil downhill until a decreasing slope causes it to be deposited. If, however, a good structure can be maintained the soil absorbs water more quickly for soils with a good structure have numbers of minute channels through which rain can be absorbed.

Experiments have shown that surface cover protects the soil structure and prevents soil erosion almost completely. A minimum of cultivation and a maximum of surface cover are fundamentals in preventing soil erosion by water action. In most of South Western Australia it is impossible to obtain good pastures without the use of subterranean clover which, in addition, plays an important part in improving soil structure and soil fertility.

Wind Erosion

Ridged or cloddy cultivations are effective in preventing wind erosion until blown smooth. Pasture, if not overgrazed, will provide a more effective and longer lasting surface roughness and if sufficiently dense will prevent the lifting of fine dust.

The value of root material in binding the soil and preventing erosion is frequently emphasised but without minimizing the value of this effect the provision of effective cover of the soil surface is the paramount need.

Soil Salinity

The development of improved pastures which, in this State usually means pastures, containing subterranean clover would use more water from the soil and tend to minimize the extent of salt encroachment due to concentration of run-off water in valleys.

Subterranean clover pastures have frequently arrested soil erosion in W.A. They have provided the dense pasture cover which is so necessary and when used in the wheatbelt has lengthend the the period of surface cover as bare fallow is not required after a leguminous pasture. Its ability to grow in subsoil is also of great value.

The inevitable conclusion is that pasture is the best, the cheapest and the most widely applicable soil conservation method of W.A. As subterranean clover is the only plant which develops good pasture in this area these remarks apply directly to subterranean clover, and when good clover pastures are developed on all suitable soils having enough rain to grow the plant the work of soil conservation in South Western Australia will be well started.

IV. Subterranean Clover and Fertility in Stock

By PROFESSOR E. J. UNDERWOOD

So much publicity has been given in recent years to "Sheep Infertility and Dystocia Problem" on subterranean clover pastures that the great benefits conferred on stock by this pasture species is often overlooked.

These benefits come from the improvements in quantity and quality of grazing which have resulted from the use of subterranean clover. No other pasture species approaches this plant in yield or productivity per acre or in capacity for

conservation as clover or "meadow" hay. Its superiority during the summer period is particularly marked owing to its palatability and availability to stock in the dry stage. In addition, subterranean clover has a higher content of *protein,* than most other pastures species at all growth stages. For instance, good clover hay is more than twice as rich in protein as good cereal hay and in the dry stage subterranean clover contains two to three times as much protein as such other pasture species as silver grass or capeweed at the same stage.

Increased Carrying Capacity.

The increased carrying capacity of pastures improved with subterranean clover is well known but there is also a substantial increase in health and productivity of the stock carried. The higher protein content of the dry pastures helps maintain milk yield and wool yield during the summer when protein shortage is most liable to occur. Sheep mortality is also reduced.

It must be emphasised that fertility in sheep is not merely a matter of getting ewes in lamb. The lambs must be reared to maturity.

Prior to the improvement of pastures with subterranean clover high lamb mortality was common, unthriftiness and death in weaners was prevalent and "worm" troubles were a frequent cause of complaint by farmers. It cannot be claimed that these difficulties have entirely disappeared, following the raising of the general level of nutrition with subterranean clover, but they have been very greatly reduced. This is the experience of a number of farmers. One well-known farmer reports that he had a regular lamb and weaner mortality of about fifteen to eighteen per cent. in his flock. Since the development of subterranean clover pastures and the feeding of clover hay in the late summer and autumn months his lamb mortality has been reduced to an average of about three per cent. and his weaner mortality and "worm" troubles practically eliminated.

Farming Methods

These are very substantial benefits to the farmer and taken in conjunction with methods already suggested by the scienists engaged in solving the "clover infertility problem" place subterranean clover in a unique position among plant species in the agriculture of the State. These methods may briefly be stated as (1) keep all ewes off green subterranean clover dominant pasture, (2) every three or four years tear up subterranean clover pastures and sow oats for grazing or wheat for grain, following by oats for grazing, (3) sow Wimmera rye grass with the cereal to "balance" the subsequent pastures, (4) conserve clover hay, which is much less "toxic" than the green clover, for feeding during summer and autumn. It cannot be claimed that this will entirely prevent infertility or dystocia, but it is sound advice and a number of farmers are using the system successfully.

V. Problems Awaiting Investigation

By R. C. ROSSITER

Most of the main problems requiring investigation can be grouped into four categories.

1. *The precise role of subterranean clover in the build up of soil fertility.*

That subterranean clover being a legume does build up soil fertility is obvious and evidence shows that this build up may be fairly rapid even over the first few years. Quantitative data are needed on the following four points:—

(a) Increase in soil nitrogen and organic matter with time.

(b) Structural properties of the soil. The examination of the effects of subterranean clover on this point will require carefully controlled experimentation.

(c) Changes in soil microflora of which very little is known.

(d) General fertility as measured by crop growth (more particularly a cereal).

In investigations of the above type adequate consideration must be given to design and experimental technique, the experiments are necessarily of long duration and faulty planning cannot be afforded.

2. *Plant nutrition studies on subterranean clover.*

Here again the field of work about which accurate information is required is that in which the basic generalization is recognized, viz., that superphosphate is necessary for the satisfactory growth of clover.

Information is required under field conditions of grazing on not only rates but placement effects, residual effects and, of course, phosphate fixation.

Of the other major nutrients potassium is probably the most important, while among the minor elements copper and zinc are perhaps of most importance to subterranean clover in W.A.

To the scientist the interaction effects of the various essential plant nutrients presents some interesting problems and very frequently such studies assist very materially in the understanding of apparently inexplicable field observations. The problem of nitrogen nutrition of subterranean clover also should not be overlooked. A complete examination of the very numerous Rhizobium strains may conceivably lead to increased productivity of subterranean clover.

3. *Investigations of strain characteristics.*

The general characteristics of subterranean clover as a plant species are of course well known—the ability to withstand heavy and continuous grazing and to reproduce itself under such conditions, but very little attention has been given to the agronomical characteristics of the various strains—there are now over 30 quite distinct strains of subterranean clover. There is, too, the problem of the variation in nutritional requirements of the subterranean clover strains. There is some recent evidence which strongly indicates a strain difference in the reaction to at least one of the essential elements.

4. *The question of associated species in subterranean clover pastures or factors affecting the botanical composition of subterranean clover pastures.*

For a number of reasons introduced perennial grasses have not been successful except on a very limited scale. The stability in botanical composition which perennial grass usually provides will like wise be restricted.

With our sheep pastures the most impressive feature from the standpoint of botanical composition seems to be the absence of grass and it seems that the presence or absence of grass is an index of under or over grazing. Further, if substantial amounts of grass are present in the pasture, then the likelihood of the sheep consuming appreciable amounts of clover, in the growing season, is remote. A great deal of the pasture work must be directed to ways and means of producing and maintaining a pasture of reasonable carrying capacity yet "healthy" from the viewpoint of such serious stock problems as infertility in sheep.

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TECHNICAL PAPERS

THE PEANUT PRODUCTION SCHEME IN BRITISH EAST AFRICA — with a Comparison between the Climates of Certain Localities in British East Africa and Tropical Australia

By I. MOLNAR

In recent months considerable publicity has been given in the daily press to the tours made in northern Australia by representatives of the British Overseas Food Corporation. The proposed agricultural development of part of our north by this Corporation attracted the attention of the public. For the time being, about 30,000 acres have been selected around Clermont, in Queensland, with the aim of sorghum and pig production for Britain. The Queensland Government provided half of the total capital of £2,000,000 for the enterprise. The project is under the joint management of the B.O.F.C. and the Government of Queensland, and developmental works in the Clermont area are already in progress.

Much less publicity has been given, however, to the large-scale peanut growing scheme in British East Africa under the auspices of the same Corporation. This scheme in East Africa involves a public organisation with a capital of £50,000,000. It is of some interest to see the background to the B.O.F.C., the progress which has been made in East Africa, and how the climate of East Africa compares with that of tropical Australia.

1. The Establishment of the British Overseas Food Corporation

After the loss of the American colonies the financial administration of the British colonies was kept independent from the Mother Country. Some loans were made to them at times, but generally they had to meet their needs from their own revenue. During the economic depression in 1929, an annual appropriation of £1,000,000 was provided for the colonies for their economic development under the Colonial Development Act. The ultimate aim of this Act was to relieve unemployment in Britain by increasing the purchasing power of the colonies. As a result of the Mayne Royal Commission an increase in the annual assistance from £1,000,000 to £5,500,000 a year for a ten year period was proposed in the Colonial Development and Welfare Bill of 1940. When the Bill passed the Houses in 1945 the assistance became £120,000,000, spread over ten years, and it had provisions for colonial developmental works and research. Each colony had to submit its ten-year plan for economic and social service development. For any such plan which had been approved by the Colonial Economic and Development Council in London, the Exchequer would provide part of the necessary finance.

Due to the poverty of the farmers in many British colonies their peasant agriculture is not only primitive but also soil-exploiting. An annual £12,000,000 assistance was considered to be inadequate to bring about a major improvement in their social and agricultural structure. Some further means of bringing more money into these countries would be necessary and this meant a new

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enterprise. It was realised that some form of public corporation only could develop the millions of acres of unproductive land in many colonies. Since large amounts of capital over a long period were required to develop such areas and establish modern agricultural practices, a start in these directions could not be expected from private enterprise.

Before World War II the Empire almost entirely supplied the U.K. with peanuts. In 1938, for instance, 318,000 tons were imported, and over two-thirds of this quantity came from India (18). Due to the large increase in India's population, her peanut exports declined rapidly after the war, while Britain's need for fats of every description became a major problem. In these circumstances, early in 1946, the United Africa Company approached the British Government with a plan for large-scale peanut production in British East Africa. A corporation financed by the government, was suggested for this purpose, with the aim of obtaining part of Britain's fat requirements in the form of peanuts and peanut oil from B.E.A. The United Africa Company's plan had been worked out in some detail; the areas concerned were in Tanganyika Territory, Kenya and Northern Rhodesia. The British Government considered the plan of sufficient importance for more thorough investigation. A mission, consisting of three members, was sent to the proposed areas, and on their return to Britain they submitted their report to the Secretary of State for the Colonies (13). In their report they advised the government to develop eighty units of land in Tanganyika Territory, seventeen units in Northern Rhodesia, and ten units in Kenya, each unit consisting of 30,000 acres, making a total area of 3,210,000 acres (*Fig.* 1). The proposed areas were almost entirely uninhabitated and, because of their dense bush cover, infested with tsetse fly. The clearing of the native vegetation could, however, free them from this pest. More recent surveys in Kenya have shown that, for reasons so far not specified, the selected ten units are not suitable for peanut growing. Either alternative areas will have to be found in Kenya itself, or further locations will be selected in southern Tanganyika (14).

At the end of 1946 the British Government adopted the mission's report completely, and the United Africa Company was asked to act as managing agents during the initial stages of the developmental work. The first start was made in January, 1947, in central Tanganyika in the Kongwa area, west of Dar-es-Salaam.

Two corporations were established by the Overseas Resources Act of February, 1948—the British Overseas Food Corporation and the Colonial Development Corporation. While the duties of the former involved the production, processing and marketing of foodstuffs or other products in places outside the United Kingdom with a capital of £50,000,000, the latter corporation, with a capital of £100,000,000 was charged with duties for the development in colonial territories (15). Although the areas in British East Africa were either colonies or mandated territories, the B.O.F.C., and not the C.D.C., was empowered to carry out the peanut production scheme. It proved to be more practical to leave this task to a public enterprise than to bring it under the jurisdiction of the Secretary of State for the Colonies (16). Simultaneously with the passing of this Act, steps were taken to hand over the administration of the British East African peanut scheme from the United Africa Company to the B.O.F.C.

The whole operation, both developmental and agricultural, was based on the use of mechanical equipment on a large scale. A rotation of peanuts with other crops and with pasture was planned. The peak requirements of labour were estimated at over 1,000 Europeans and over 57,000 Africans. The estimated capital cost of the project was roughly £24,000,000, or £7/9/6 per acre. In this

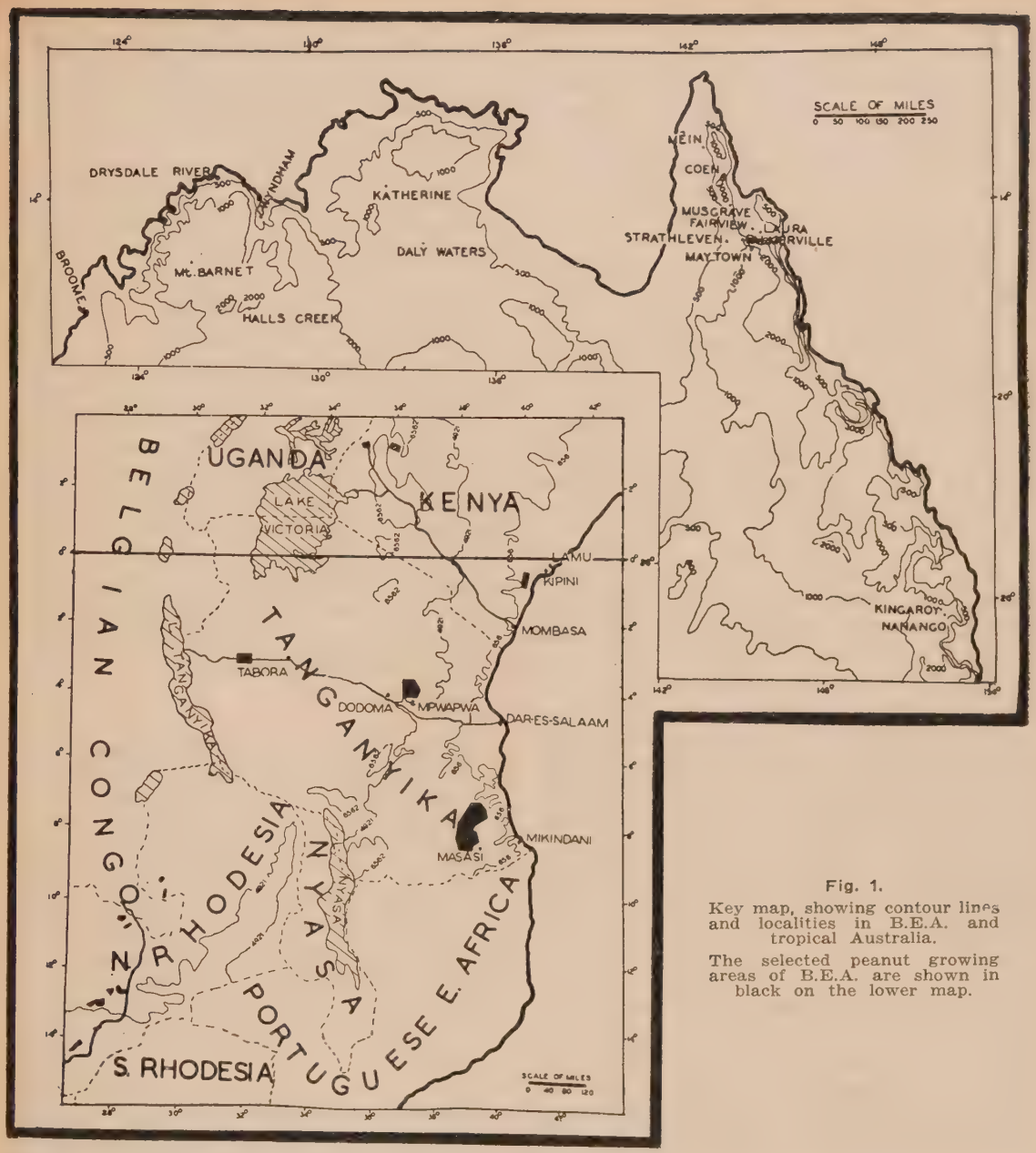


Fig. 1.

Key map, showing contour lines and localities in B.E.A. and tropical Australia.

The selected peanut growing areas of B.E.A. are shown in black on the lower map.

amount clearing equipment, clearing operations, installations and agricultural machinery were all included. The financial soundness of the proposition depended on two estimates—an average yield of eight hundred and fifty pounds of shelled nuts per acre, and a production cost, with full provision for amortisation, of £14/15/6 per ton of shelled nuts f.o.b. When the mission's report was submitted to the government it cost £32 per ton to purchase peanuts in Asia; hence an annual production of 600,000 tons in B.E.A. could mean a saving for Britain of over £10,000,000 per year.

In addition to the cheap fat supply for Britain, the proposed scheme is intended to provide a means of improving the

social condition of the native people employed. It means large-scale employment of Africans, the rehabilitation of African ex-servicemen, and a change-over from the primitive soil-exploiting, peasant agriculture to a modern system.

2. Progress up till November 1947

The target of the first year's operations was to clear 150,000 acres of bush for plantings by the end of 1947. For this target two hundred heavy tractors were required. Mainly because of the difficulties in obtaining the required heavy equipment, and because they were forced to use second-hand army disposal machinery, most of which was obtained from the Philippines, the set goal could not be achieved.

By the 1st July, 1947, ninety-seven clearing tractors had arrived at Kongwa, so that clearing operations could start on a substantial scale, although at a much later date than expected. Therefore, only about 8,000 to 10,000 acres had been prepared for planting in December, 1947. Although the relatively slow progress can be attributed mainly to the lack of the necessary equipment, several other obstacles also hindered progress. First among these was the difficulty in de-rooting the thorny underground parts of the dense native bush. As in our Mallee, the flattening of this vegetation proved to be a much easier task than the de-rooting of the sub-surface residue after the surface debris had been moved into windrows. Originally it was expected that the heavy equipment could pull out the entire plant, and considerable time elapsed before efficient methods were developed. Furthermore, due to the initial developmental work in making railways, roads and preparing building sites, in no one week have more than 872 tractor hours been spent on flattening the bush, and no more than 2,590 tractor hours in windrowing. Other hindering factors were the lack of skilled technicians in sufficient number, the lack of spare parts for the second-hand equipment, congestion at Dar-es-Salaam, the nearest port of the Territory (without deep-sea berth), insufficient rolling stock on the railways, and many others.

The total amount spent on the scheme up till the 30th November, 1947, was £4,250,000, which was almost entirely capital expenditure. Since the prices of equipment and also of peanuts have risen considerably since the original estimates were made, no new production cost can be forecasted. It is promising, however, that on the basis of seven small trial plots planted in January, 1947, a 900 lb. per acre crop can be expected, on the average, from last December's large-scale plantings; incidentally, the soils of these experimental plots had only a low fertility. The yield on the most fertile plots amount to 1,580 lb. per acre. These figures may be compared with the estimated 750 lb. of decorticated peanuts per acre, used as a basis for calculations in the mission's report.

At the end of November, 1947, a European staff of four hundred, and five thousand five hundred Africans, were employed on the work in Kongwa. Another one thousand Africans were employed in the western and southern parts of Tanganyika, in areas to be developed during this year. The African labour proved to be adaptable for semi-skilled work and, with training facilities provided in several trades, labour shortage will become less severe. By the end of November, 1947, four hundred and fifty-six African drivers passed the school for tractor clearing and two hundred and forty the "agricultural tractor school." In both schools failures to qualify were less than sixteen per cent. Teaching facilities are generally improving, and provisions are made for the use of films, film strips, gramophones, etc., for technical teaching. Methods used in the Indian Army for rapid mass teaching of basic English during the war will be adopted in East Africa.

Both the European and African staff live in tents because, due to the lack of suitable timber in the Kongwa area, it is very difficult to provide the necessary buildings. In other areas, however, useful timber will be available not only for local buildings but probably on a commercial scale.

A sixteen mile extension has been built from the railway line in central Tanganyika to Kongwa. Work also began on a new one hundred and twenty mile railway to connect the proposed southern peanut producing areas of 1,500,000 acres with the proposed new port at Mikindani. A pipe line running from Mikindani to these southern areas is also contemplated.

Investigations are made on varieties, crop rotation, fertilisers, seeds, soils and many other matters which have a bearing on the scheme. The recently discovered phosphate deposits of Uganda will provide the phosphate requirements of the future.

3. The Basis of the Climatological Comparison between British East African and Tropical Australian Localities

The two indices of climatic moisture conditions most widely used in Australia were developed at the Waite Institute under the "Mediterranean" climatic conditions of Adelaide. These are firstly, the precipitation: evaporation (P/E) ratio, and secondly, the precipitation: saturation deficit (P/S.D.) ratio. For the present discussion the latter index was chosen because, for comparative purposes, it is preferable to the former. To show this, it becomes necessary to give a brief description of the experimental basis of both indices.

To determine the P/E ratio, blocks of Waite Institute soil were placed in glass jars and 0.20 to 0.60 inch of water was added to them "at the hygroscopic coefficient"; the blocks were then covered with paper. They were kept over a period of weeks and weighed three times daily. The evaporation from the soil blocks was compared with that from a standard evaporimeter 36 inches in diameter, placed alongside the jars. A P/E ratio (where E=evaporation from evaporimeter, and P=water added to the soil) of approximately 1/3 was found, on the average, to be necessary to keep the moisture content of blocks above the wilting point (11). This finding was substantiated by using different soil types (12).

Evaporimeters are installed at only a few stations in Australia. A good correlation has been found, however, between evaporation from a standard evaporimeter and the saturation deficit (9 a.m. readings) at 12 selected stations. By multiplying the monthly mean saturation deficit (inches of mercury) by 21.2, when evaporimeter readings are unavailable, saturation deficit values can be converted to monthly evaporation (8). In British East Africa, however, evaporation is measured by the Pichè atmometer. Evaporation figures, at four different stations based on Pichè atmometer readings do not agree at all with that calculated on the 21.2 times saturation deficit basis, with the exception of the figures for the coastal station at Mombasa. Prescott also was unable to find agreement between the standard tank evaporimeter and the Pichè atmometer readings in Adelaide and Brisbane (9).

Evaporation from the soil varies according to the water content of the soil, and is comparable with that from a free water surface when the soil surface is even, free of vegetation, "until approximately 50 per cent. of the saturation capacity had been reached" (12). Below this point evaporation falls off rapidly (12). Due to the water penetration in soils, it generally will take longer for the water to evaporate from soils than from a free water surface (11). However, the P/E indices for measuring effective rainfall hold good only for cool-season rainfall conditions (e.g., Adelaide). Under tropical conditions where temperature

and rainfall, and hence evaporation from the soil, differ greatly from Adelaide, new P/E indices have to be determined. There is no proof of any assumed lower index values, such as 0.20 or 0.25, under tropical conditions (12), although 0.25 index has been used in a study of the climate of Tropical Australia (4).

The P/S.D. ratio was determined by observing soil moisture conditions, twice weekly, on a fallowed soil at the Waite Institute. It was found that the surface four inches of soil was maintained above the wilting point when the P/S.D. ratio exceeded a value of 5 (6, 8). On the other hand, a ratio of 35 is considered to correspond to the evaporation "from a saturated soil or from an actively growing dense crop under ideal conditions" (7). At this ratio evaporation and/or transpiration is about 1.6 to 1.7 times that from a free water surface (7).

The P/S.D.=5 index has been determined only on a single soil type (sandy loam of the red-brown earth type) (8, 10) and only at Adelaide, hence this index also has its limitations. However, the P/S.D. index can be more readily calculated than the P/E indices because when evaporation figures are not available there is no need to compute evaporation from saturation deficit figures. The climate of Tropical Australia and B.E.A. cannot be compared by converting S.D. to E. because the conversion factor has not been determined for B.E.A. Therefore, in the present study, similarly to Prescott's work on the climate of Nigeria (7), the P/S.D.=5 index is used as a guide to the climatic moisture conditions (11).

"About 200 stations conveniently chosen" from all over the world were studied by de Martonne who used the "aridity indices" (3). He found that the calculated index values of these 200 stations were related to the climatic moisture conditions. Accordingly certain index values were chosen, which he considered as characteristic of certain climates. Although some Australian workers used these indices (1, 5), they do not claim that these are specially accurate.

The aim of this study was to compare the climate of B.E.A. with localities in tropical Australia, and also with two existing Australian peanut growing localities, such as Kingaroy and Kath-

Photo: Q'land Dept. of Agric. and Stock.

Brown Spanish Peanuts in the Kingaroy District. Generally, early maturing characterises the Spanish types.

erine. Therefore, the arbitrary criteria used in a study of the climate of the Katherine-Darwin region (2), could not be followed as starting points for two reasons. Firstly, weekly rainfall data, for determining the "start of the season," would have to be obtained from B.E.A. Secondly, in the Katherine-Darwin region survey, a 3 inch rainfall over consecutive 28-day periods (assessed at 14-day intervals) was used as a criterion for "adequate rainfall" which would mean that at Kingaroy one could not grow peanuts as a major crop. In Queensland peanuts need a growing period of 16 weeks as a minimum (17). In this study, therefore, monthly rainfall variability percentage figures are used as a yard-stick for measuring rainfall reliability, and 2 inches minimum monthly rainfall with a P/S.D. ratio greater than five for measuring "adequate rainfall."

Since there is no climatological station at Kingaroy, the nearest station, Nanango, was chosen as a substitute. Similarly, where temperature readings were not available to calculate the saturation deficit, i.e., at Maytown, Strathleven, Mt. Barnet, saturation deficit observations at the nearest stations, i.e., at Palmerville, Fairview, and Halls Creek were used respectively. In British East Africa there are only a few stations with sufficiently long rainfall records around the proposed peanut growing areas, and there are still fewer stations where temperature readings are taken. For these reasons a complete comparison could not be made.

TABLE I

Locality	Number of years used for computing	
	Mean rainfall and standard deviation	Rainfall per wet day
Nanango	61	56
Katherine . ..	70	30
TABORA	37	16
Strathleven ..	22	15
Laura	43	37
MOMBASA ..	55	16
Mein	41	41
LAMU	40	14
Maytown	59	54
Drysdale River	32	27
MASASI	26	17
Mt. Barnet . ..	19	17
KIPINI	30	15
Coen	56	51
Musgrave	42	42
MPWAPWA ..	18	—
Daly Waters ..	70	30
Wyndham . ..	56	30
DODOMA . ..	18	—
Broome	52	30

As in Prescott's study of Nigeria (7) stations were selected from tropical Australia which had a mean annual rainfall approximately the same as those in British East Africa. Corresponding stations were then analysed. The saturation deficit values used were average values during a period of over 25 years for most of the Australian stations, while averages of a shorter period were used in the case of British East Africa. Since tropical localities were considered, it was assumed that temperature was always satisfactory.

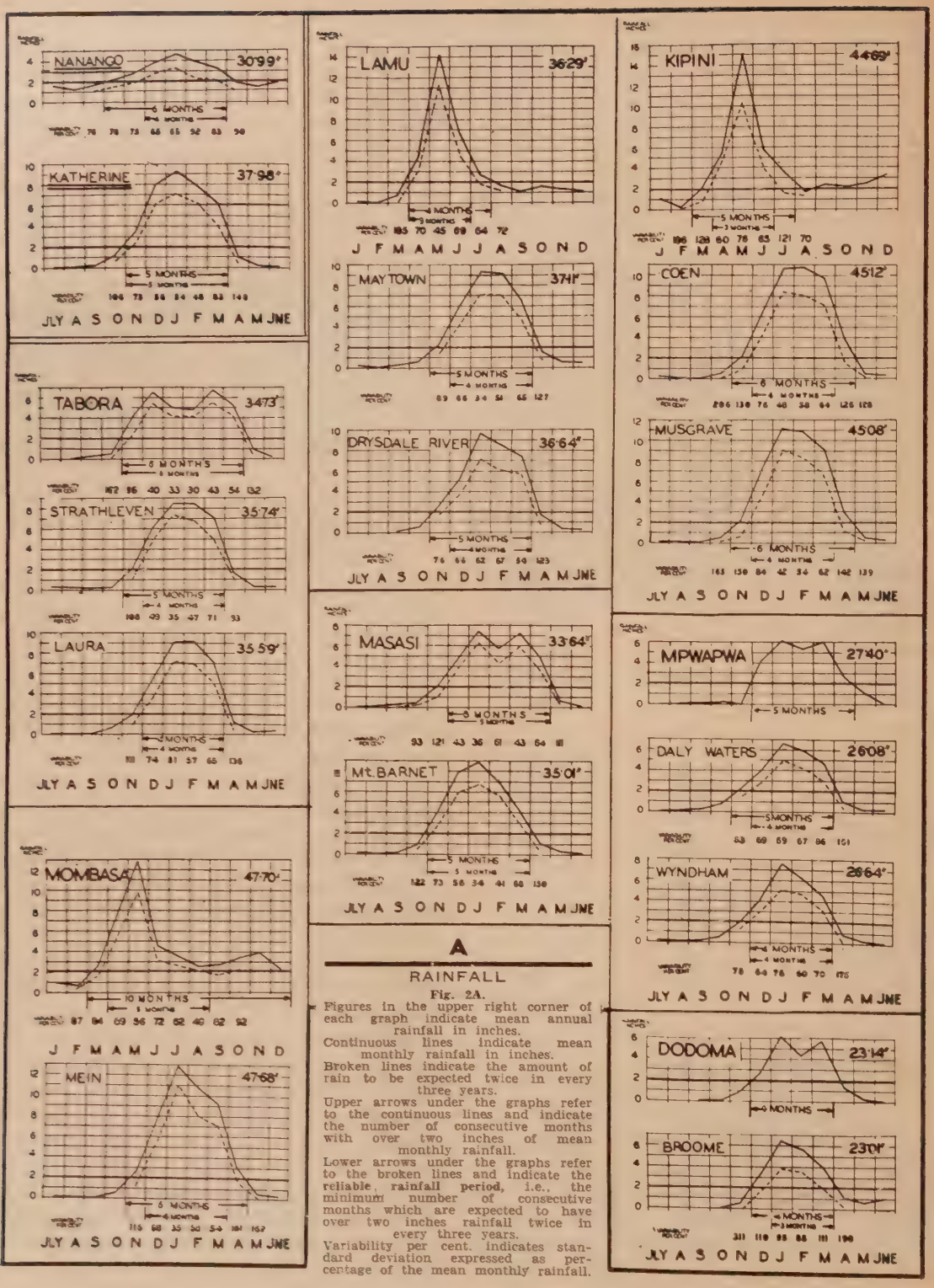
Photo: Q'land Dept. of Agric. and Stock.
Peanut Silos at Kingaroy.
The main storage facilities are at Kingaroy, but the Queensland Peanut Board has also depots at Brisbane, Atherton and Rockhampton.

The number of years used for computing the mean rainfall, standard deviation and rainfall per wet day are set out in Table I.

4. Comparison between the Climate of Certain Localities in British East Africa and Tropical Australia

The findings of the climatological analysis are shown in Fig. 2 A and B and in Table II. Since only incomplete data were available for British East Africa, it became necessary to use three terms when comparing the climate of the various localities.

These terms are as follows:—reliable rainfall period, indicated by the lower arrows under the graphs in Fig. 2A; length of the season, indicated by the upper arrows in Fig. 2B; and the reliable season, indicated by the lower arrows under the graphs in Fig. 2B. The figures in the second last column of Table II are used when the length of the growing period is discussed. The start and end of the "reliable rainfall periods" and of the "seasons" and "reliable seasons" are specially mentioned since the less erratic


NANANGO 30·99"
KATHERINE 37·98"
JLY A S O N D J F M A M JNE
LAMU 36·29"
MAY TOWN 37·11"
DRYSDALE RIVER 36·64"
JLY A S O N D J F M A M JNE
KIPINI 44·69"
COEN 45·12"
MUSGRAVE 45·08"
JLY A S O N D J F M A M JNE
TABORA 34·73"
STRATHLEVEN 35·74"
LAURA 35·59"
JLY A S O N D J F M A M JNE
MASASI 33·64"
Mt. BARNET 35·01"
JLY A S O N D J F M A M JNE
MPWAPWA 27·40"
DALY WATERS 26·08"
WYNDHAM 28·64"
JLY A S O N D J F M A M JNE
MOMBASA 47·70"
J F M A M J J A S O N D
MEIN 47·68"
JLY A S O N D J F M A M JNE
DODOMA 23·14"
BROOME 23·01"
JLY A S O N D J F M A M JNE

A

RAINFALL

Fig. 2A.

Figures in the upper right corner of each graph indicate mean annual rainfall in inches.

Continuous lines indicate mean monthly rainfall in inches.

Broken lines indicate the amount of rain to be expected twice in every three years.

Upper arrows under the graphs refer to the continuous lines and indicate the number of consecutive months with over two inches of mean monthly rainfall.

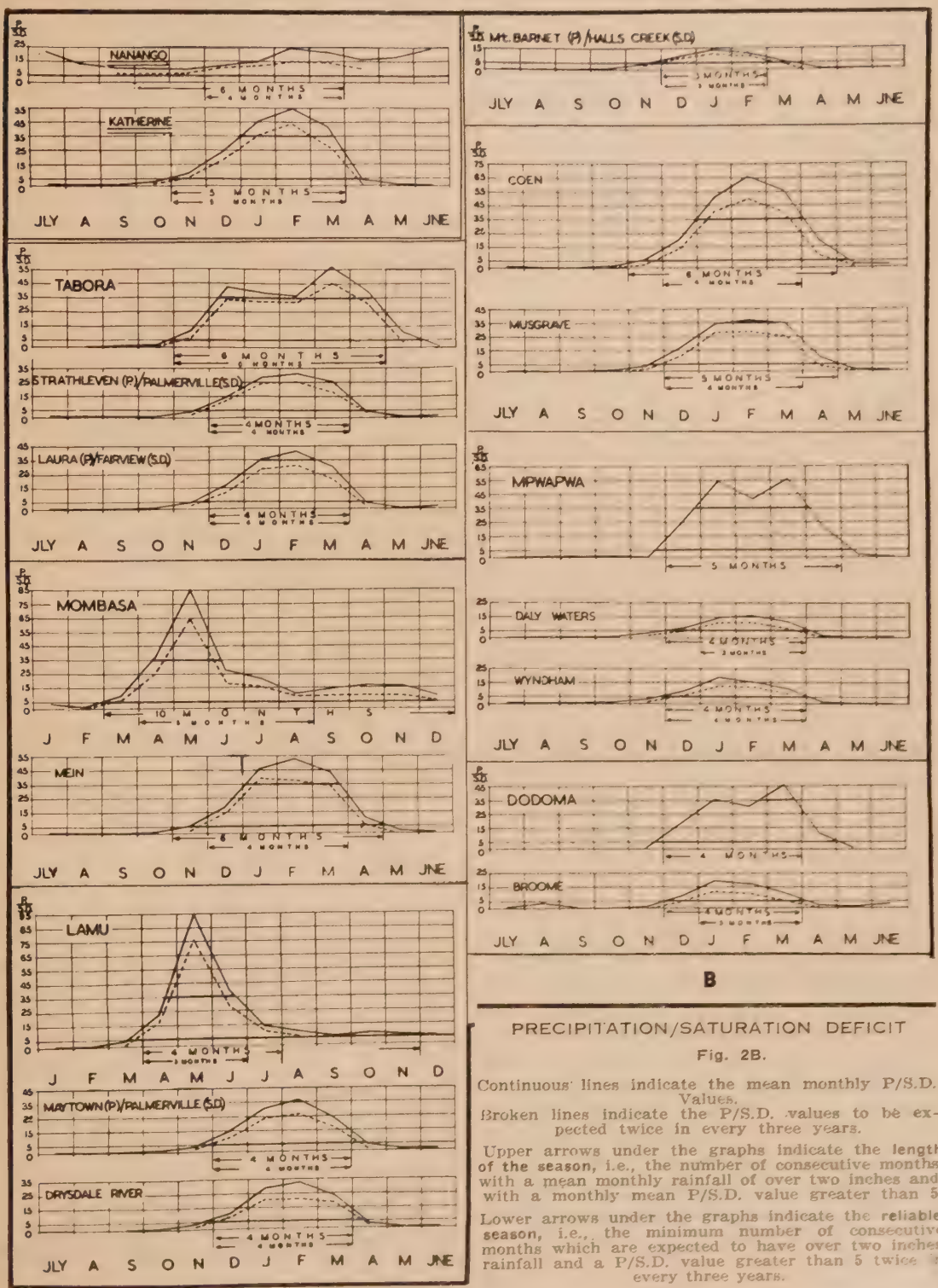
Lower arrows under the graphs refer to the broken lines and indicate the **reliable rainfall period**, i.e., the minimum number of consecutive months which are expected to have over two inches rainfall twice in every three years.

Variability per cent. indicates standard deviation expressed as percentage of the mean monthly rainfall.

Figs. 2A and B.

Graphs showing the rainfall (A), and saturation deficit (B) characteristics of the British East African and tropical Australian localities.

The graphs of the Australian localities are placed below the graph of that British East African locality to which their mean annual rainfall corresponds.


NANANGO
6 MONTHS
KATHERINE
5 MONTHS
JLY A S O N D J F M A M JNE
TABORA
6 MONTHS
STRATHLEVEN (P.)/PALMERVILLE(S.D.)
4 MONTHS
LAURA (P.)/FAIRVIEW (S.D.)
4 MONTHS
JLY A S O N D J F M A M JNE
MOMBASA
10 MONTHS
J F M A M J J A S O N D
MEIN
6 MONTHS
JLY A S O N D J F M A M JNE
LAMU
4 MONTHS
J F M A M J J A S O N D
MARYTOWN (P.)/PALMERVILLE (S.D.)
4 MONTHS
DRYSDALE RIVER
4 MONTHS
JLY A S O N D J F M A M JNE
MT. BARNET (P.)/HALLS CREEK (S.D.)
3 MONTHS
JLY A S O N D J F M A M JNE
COEN
6 MONTHS
MUSGRAVE
5 MONTHS
JLY A S O N D J F M A M JNE
MIPWAPWA
5 MONTHS
DALY WATERS
2 MONTHS
WYNDHAM
4 MONTHS
JLY A S O N D J F M A M JNE
DODOMA
4 MONTHS
BROOME
2 MONTHS
JLY A S O N D J F M A M JNE

B

PRECIPITATION/SATURATION DEFICIT

Fig. 2B.

Continuous lines indicate the mean monthly P/S.D. Values.

Broken lines indicate the P/S.D. values to be expected twice in every three years.

Upper arrows under the graphs indicate the length of the season, i.e., the number of consecutive months with a mean monthly rainfall of over two inches and with a monthly mean P/S.D. value greater than 5.

Lower arrows under the graphs indicate the reliable season, i.e., the minimum number of consecutive months which are expected to have over two inches rainfall and a P/S.D. value greater than 5 twice in every three years.

TABLE II

LOCALITY	Number of seasons analysed for growing period	GROWING PERIOD Seasons grouped according to number of consecutive months with over 2 inches rainfall and with a P/S.D. value greater than 5, and expressed as percentage of the number of seasons analysed										Mean growing period (No. of months)	Percentage of the analysed with 4 or seasons more months growing period	Rain per wet day (rainfall intensity)
		1	2	3	4	5	6	7	8	9	10			Points
Nanango ..	60	8.3	26.7	15.0	25.0	16.7	3.3	3.3	1.7			3.5	50.0	38
Katherine ..	70		4.3	7.1	38.6	38.6	10.0	1.4				4.5	88.6	60
TABORA ..	38		7.9	2.6	7.9	31.6	36.8	13.2				5.2	89.5	35
Strathleven .	20		10.0	10.0	25.0	50.0	5.0					3.3	80.0	67
Laura	41	4.9	4.9	19.5	36.6	26.8	7.3					4.0	70.7	60
MOMBASA .	57	1.8	7.0	10.5	19.3	29.8	10.5	8.7	5.3	1.8	5.3	5.1	80.7	37
Mein ..	41		7.3	12.2	17.1	31.7	24.4	7.3				4.8	80.5	47
LAMU	37	2.8	16.2	37.8	32.4	5.4	5.4					3.3	43.2	44
Maytown ..	58	1.7	3.5	17.2	39.7	27.6	10.3					4.2	77.6	49
Drysdale R.	31	3.2	3.2	25.8	45.2	16.1	6.5					3.8	67.8	54
MASASI . ..	—	—	—	—	—	—	—	—	—	—	—	—	—	45
Mt. Barnet .	19	5.2	15.8	31.6	31.6	15.8						3.4	57.4	54
KIPINI	—	—	—	—	—	—	—	—	—	—	—	—	—	41
Coen	55	1.8	5.5	12.7	27.3	29.1	20.0	3.6				4.5	80.0	52
Musgrave ..	42			19.0	26.2	40.5	11.9	2.4				4.5	81.0	59
MPWAPWA	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Daly Waters	70	14.2	24.3	38.6	20.0	2.9						2.7	22.9	46
Wyndham ..	56	8.9	12.5	39.3	28.6	10.7						3.2	39.3	45
DODOMA ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Broome . ..	53	15.1	30.2	39.6	15.1							2.5	15.0	60

NOTE.—Due to broken climatological records there is a discrepancy between the number of seasons analysed for the growing period and the number of years used for computing mean rainfall and standard deviation (Table I).

they are, the better the sowing and harvesting conditions.

(a) *British East African Localities Compared with Nanango (Kingaroy) and Katherine.*

Katherine has a higher annual rainfall, a less erratic rainfall in the middle of the season, a longer **reliable season**, and also a longer growing period than **Nanango.** Although at Katherine the start of the reliable season is somewhat more erratic, the end of the season is much less so. Nanango has less torrential rain, as is shown by the lower rainfall per wet day (rainfall intensity). In this respect Nanango is better than any other Australian locality used in this work.

TABORA is climatologically better in almost every respect than Nanango, and much better than the other East African stations. Although it has only a slightly lower mean annual rainfall than Katherine, in all other respects it is superior to it. It has the least erratic rainfall among all the stations considered, and a **reliable season** one month longer than Katherine. The growing period is slightly longer at Tabora than at Katherine, and the rainfall slightly less intense than at Nanango. Only the start of the season is more erratic at Tabora than at Nanango, but the longer season at Tabora compensates for this.

MOMBASA has a much higher annual rainfall than Katherine. The length of the **reliable season** of Mombasa equals that of Katherine, but its end is less erratic. On the other hand Mombasa has a shorter growing period and a highly erratic rainfall in the middle of the season. The intensity of the rainfall is comparable with that at Nanango.

LAMU has only a little lower annual rainfall than Katherine. The beginning of the **reliable season** is about as erratic at Lamu as at Katherine, the end of the season less erratic than either at Katherine or Nanango, while the rainfall intensity is between these two stations. In other respects Lamu is inferior to both of them. At Lamu the length of the reliable season is only three months; on this score this locality is doubtful for peanut growing, if a growing period of 16 weeks is taken as the minimum requirement.

MASASI. For this locality only rainfall comparisons can be made; these show

that the annual rainfall and the intensity of the rainfall are between those of Nanango and Katherine. The **reliable rainfall period** is the same at Masasi as at Katherine. The beginning and the end of this period, however, is less erratic, while the middle portion is more erratic than at Katherine.

KIPINI. For this station again only rainfall comparisons can be made. Kipini has a higher mean annual rainfall than Katherine and a rainfall intensity slightly greater than Nanango. As at Masasi, the beginning and the end of the **reliable rainfall period** is less erratic, while the middle portion is more so than at Katherine. Due to the short reliable rainfall period this locality, like Lamu, is uncertain for peanut growing.

MPWAPWA. Since sufficiently long records are not available for this station, only its **length of season** can be compared with that of Nanango and Katherine. On this basis Mpwapwa is equal to Katherine and, because of the much higher monthly mean P/S.D. values at Mpwapwa, superior to Nanango.

DODOMA. Sufficiently long records are not available for Dodoma either. Hence, here again, only the **length of the season** can be compared. Because Dodoma has a shorter season than either Nanango or Katherine it is inferior to them.

(b) *Comparison between the British East African localities and those in Australia which have approximately the same Annual Mean Rainfall.*

Tabora Compared with Strathleven and Laura

The start of the **reliable season** at Tabora has a more erratic rainfall than the corresponding Australian localities. Otherwise Tabora is far superior to both Strathleven and Laura.

Mombasa Compared with Mein

The **reliable season** at Mombasa is a month longer than at Mein, but the former locality has a more erratic rainfall in the middle of the season than the latter. In other respects these two localities are about equal.

Lamu Compared with Maytown and Drysdale River

Only the intensity of the rainfall is in favour of Lamu. In every other respect Maytown and Drysdale River are considerably better.

Masasi Compared with Mt. Barnet

For this locality only rainfall comparisons could be made. The length of the **reliable rainfall period** is the same at Masasi as at Mt. Barnet. At Masasi the beginning of this period is less erratic and the middle portion more so than at Mt. Barnet.

Kipini Compared with Coen and Musgrave

Similarly to Masasi, here again, only rainfall comparisons could be made. At these Australian localities the length of the **reliable rainfall period** is longer and its middle less erratic than at Kipini. The start of this period, and the intensity of the rainfall, are more favourable at Kipini than at Coen, and very much more favourable than at Musgrave.

Mpwapwa Compared with Daly Waters and Wyndham

Here only the **length of the seasons** can be compared. In this respect Mpwapwa is better than either Daly Waters or Wyndham because Mpwapwa has a month longer season and also a higher monthly mean of P/S.D. values.

Dodoma Compared with Broome

As in the former case, these stations cannot be fully compared. Although the **length of the season** is identical for both localities, Dodoma has much higher monthly mean P/S.D. values, and hence better than Broome.

(c) *Nanango (Kingaroy) and Katherine Compared with the Other Tropical Australian Localities*

Under the former headings of (a) and (b) no complete comparisons could be made. Information with regard to the Australian localities is, however, complete, and hence Nanango and Katherine can be fully compared with the other Australian localities. These comparisons are summarised in Table III.

TABLE III

Climatic Features of Various Australian Localities Compared with Nanango and Katherine.

	Locality Compared	CLIMATIC FEATURES						
		Annual Rainfall	Rainfall Variability			Rainfall intensity	Length of the reliable season	Length of the growing period
			at the start of the reliable season	at the middle of the reliable season	at the end of the reliable season			
Nanango	Strathleven	+	+	+	+	—	0	+
	Laura	+	—	+	+	—	0	+
	Mein	+	0	+	+	—	0	+
	Maytown	+	0	+	+	—	0	+
	Drysdale R.	+	0	+	+	—	0	+
	Mt. Barnet	+	—	+	+	—	—	+
	Coen	+	—	+	+	—	0	+
	Musgrave	+	—	+	+	—	0	+
	Daly Waters ..	—	0	+	0	—	—	—
	Wyndham	—	0	0	0	—	0	—
	Broome	—	—	—	—	—	—	—
Katherine	Strathleven	—	+	+	+	—	—	—
	Laura	—	0	0	+	0	—	—
	Mein	+	0	+	+	+	—	—
	Maytown	0	+	0	+	+	—	—
	Drysdale R.	0	+	—	+	+	—	—
	Mt. Barnet	—	0	0	+	+	—	—
	Coen	+	0	0	+	+	—	—
	Musgrave	+	—	0	+	0	—	—
	Daly Waters ..	—	0	—	0	+	—	—
	Wyndham	—	+	—	0	+	—	—
	Broome	—	—	—	—	0	—	—

\+ means better than Nanango or Katherine

— means worse than Nanango or Katherine.

0 means little or no difference from Nanango or Katherine.

Discussion and Conclusion

Only a generalised conclusion can be made on the basis of the presented climatological information. Accordingly, Tabora is better than any of the other British East African or Australian localities; Mombasa, Masasi and probably Mpwapwa, are equal to Katherine. The climate of Dodoma is likely to be worse than that of Nanango or Katherine; while Lamu and Kipini are definitely inferior to both Nanango and Katherine.

Mpwapwa and Dodoma are in the vicinity of those areas where the peanut growing scheme has started. Tabora and Masasi are relatively near to the areas, in west and south Tanganyika respectively, which are next on the list for clearing. Lamu, Kipini and Mombasa are all in Kenya, the colony in which all the selected

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areas so far have been rejected for peanut growing. One of these areas is situated between Lamu-Kipini and Mombasa.

Tabora and Mpwapwa are climatologically much better than the corresponding Australian localities: Dodoma, Mombasa and Masasi are about equal; while Lamu and Kipini are worse.

A number of Australian localities compare favourably in many respects with Nanango and Katherine, although the tropical stations are subject to more torrential rain than is Nanango. The comparisons show that Nanango has less intense rainfall than any of the other Australian localities. The tropical stations have less erratic rainfall in the middle and at the end of the season, and also a longer growing period. Regarding rainfall variability at the start of the season, Nanango is shown to be better in five, equal in five, and worse in one comparison with the other Australian localities.

Katherine has a longer reliable season and growing period, and in over half the comparisons a higher mean annual rainfall than the other Australian localities, at most of which, however, the rainfall intensity is more favourable. Also, at Katherine in over forty per cent of cases, the rainfall is about as erratic at the beginning and in the middle of the reliable season as in the other localities, but much more erratic towards the end of the season.

. . . . .

The information given in this paper does not, of course, mean that clear-cut decisions with regard to the suitability or unsuitability of certain localities for peanut growing can be made without much more information, especially information concerning the soils, of these localities. Although peanut crops can be grown in a wide range of soils, the plant prefers a light textured, well drained soil with a high content of organic matter. Light soils are also preferable because they facilitate the harvesting of the underground pods. Since peanuts require well drained soil, it is unlikely that peanut growing at Katherine and Kingaroy, if practised on river flats, could benefit from subsoil moisture, or run off from adjacent ground. The description of the soils of the selected areas in British East Africa, although very brief, states for almost every area that its soils are "sandy loam" or, as sometimes further specified, "red sandy loam," i.e., soils which usually give the best results with peanuts.

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MINERAL DEFICIENCY IN PLANTS ON THE SOILS OF THE NINETY MILE PLAIN IN SOUTH AUSTRALIA

III. Differences in the behaviour of the Dwalganup and later-flowering varieties of Subterranean Clover

By D. S. RICEMAN and J. K. POWRIE

For some years past, experiments have been carried out by the Council for Scientific and Industrial Research on the mineral nutrition of plants grown in some of the poor, sandy soils in the Upper South-east of South Australia. The area under investigation is known as the Ninety-mile Plain, or the Ninety-mile Desert. Most of the soils there, in their natural state, carry a dwarfed mallee or heath scrub.

It has been shown that on one of these soils, the Laffer sand described by Taylor[2], the addition of zinc, copper and phosphate is necessary to bring about satisfactory yield, seed production and persistence of the Bacchus Marsh variety of subterranean clover (Riceman[3, 5]). Omission of any one of those nutrients from the manurial treatment leads to the rapid decline and virtual disappearance of the species.

The provision of zinc and copper has enabled the Bacchus Marsh variety of subterranean clover to be established, and to be maintained in a high state of productivity, on a number of other soils in this region (Riceman[4]).

In some of the soils under investigation it has been observed that the Dwalganup variety does not behave in the same way as the Bacchus Marsh variety. The Dwalganup variety has been found to persist from year to year on soils which have not received zinc and copper; but the plants remain quite unthrifty. Moreover, addition of zinc and copper has been found to have little or no effect on the yield or seed production of that strain on these areas.

The average annual rainfall in the district under consideration is about 17 inches, the greater part of which falls during the April-November period. Before the occurrence of zinc and copper deficiency was realised, the ability of the Dwalganup variety to persist on the sandy soils was considered to be due to its early-flowering habit. However, the rapid multiplication and vigorous development of the Bacchus Marsh variety resulting from the addition of zinc and copper rendered this hypothesis untenable. Research into the reason for the continued unthriftiness of the Dwalganup variety was initiated. These studies are still in progress, but some preliminary observations seemed of sufficient importance to be brought to notice.

On one property near Coombe, the Dwalganup variety had persisted for several years, but it remained unthrifty even after the addition of a wide range of nutrient elements and other materials. The nutrient elements included Zn and Cu, and K, S, Ca, Mn, Fe, B and Mo. Superphosphate had been applied "liberally" at rates up to 2 cwt. per acre.

In one exploratory trial carried out by the owner of this property, increasingly heavy dressings of superphosphate were applied with and without molybdenum in large drill-plots. Molybdenum failed to enhance the yield at any level of phos-

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phate, but the benefit of the very heavy dressings of superphosphate was clearly evident. Zinc and copper had previously been applied to the whole area, but the clover had failed to respond. The oven dry yields of herbage which were obtained (means of 2 plots) were as follows:—

Superphosphate, per acre—	1 cwt.	2 cwt.	3 cwt.	4 cwt.	5 cwt.
Yield of subterranean clover (Dwalganup variety), cwt. per acre	2.5	11.0	12.7	17.6	25.2
Total yield*, cwt. per acre	8.9	18.3	21.5	24.8	32.4

*Total yield includes annual grasses, and some lucerne and evening primrose (Oenothera odorata).

Exceptionally heavy rainfall was recorded during the growing season. This particular field was cleared in 1938, and during the 9 years prior to the trial it had received a total of only 450 lb. of superphosphate per acre. The soil was a deep, grey siliceous sand, neutral in reaction (pH6.9). In a similar field nearby, the Bacchus Marsh variety was observed to be superior to the Dwalganup variety where zinc and copper were applied with only 187 lb. of superphosphate per acre.

On another property, the Dwalganup and Bacchus Marsh varieties were sown side by side in large drill-plots with a cereal cover crop. One-half of each plot received zinc and copper while the other half received none. All of the plots received 1½ cwt. of superphosphate per acre at seeding and a further dressing of 1½ cwt. of superphosphate per acre at the beginning of the second year. The soil there was greyish-yellow siliceous sand over yellow sandy clay.

In that trial the Bacchus Marsh variety showed a pronounced response to zinc and copper, and on the treated plots the growth in the second year was exceedingly good. The Dwalganup variety, however, showed no response to zinc and copper, and its growth remained typically weak. Sheep grazing on the dry herbage at the end of the second season showed a decided preference for the Bacchus Marsh variety.

It would seem that the poor growth of the Dwalganup variety and its lack of response to zinc and copper on some of these soils, may be the result of a still unsatisfied demand for phosphate. Such behaviour is paralleled by that of lucerne grown on Laffer sand (Riceman[5, 6]). There, lucerne was only found to respond to copper where the dressing of superphosphate was a relatively heavy one; and that species responded strikingly to increasingly heavy dressings of superphosphate, up to 8 cwt. per acre, but only if copper had been applied in addition.

The persistence and vigorous growth of the Bacchus Marsh variety of subterranean clover during the past five years on some of these soils, where zinc and copper have been provided, suggests that mineral deficiency rather than water-shortage was responsible for the failure in early attempts to establish the species. A similar situation was observed on Robe calcareous sand where "wither-tip" of oats and failure of the plants to produce grain were ascribed to a water-shortage during the early summer. Experiments showed that the condition on that soil was corrected simply by the addition of copper sulphate (Riceman and Donald[7]; Riceman, Donald and Evans[8]).

Differences in the productivity of the Dwalganup, Mt. Barker and Bacchus Marsh varieties of subterranean clover have also been observed in an experiment on Laffer sand (Riceman[4]), but the results were complicated by the presence of Wimmera ryegrass and lucerne. More detailed reference to that experiment will appear elsewhere.

Donald and Smith[1] investigated the effects of cover crops on the establishment of a mixed pasture on a sandy soil (Willalooka sand, see Taylor[9]) near Tintinara, in the Ninety-mile Plain. The species sown were Wimmera ryegrass, Phalaris, lucerne and a mixture of equal quantities of Mt. Barker and Dwalganup varieties of subterranean clover. It is of interest to note that in the third year the yield of lucerne was much higher than that of subterranean clover, and that the

clover was predominantly of the Dwalganup type. The occurrence of zinc and copper deficiency had not been realised at that time, and consequently no zinc and copper had been applied. The significance of those results is discussed further elsewhere (Riceman[5]).

In view of these observations, it seems that the persistence of the Dwalganup variety on these and some of the other poor soils in southern Australia where later-flowering varieties have failed, may sometimes be not so much a result of its earlier-flowering habit as of its apparently less exacting requirements for zinc, copper and perhaps other trace elements. Further, the apparently greater need of the Dwalganup variety for heavier dressings of superphosphate, as indicated in one of the trials described above, suggests that that variety may suffer varying degrees of incipient phosphorus deficiency in many fields even though what has been considered "liberal" applications of superphosphate, namely 1½ cwt. to 2 cwt. per acre, have been applied. This, in turn, may have some bearing upon the development of a reddish colour in the stems, a "characteristic" condition observed in that variety, and upon the lack of response to zinc and copper on some soils known to be deficient in those elements.

Elucidation of these results is being sought. Evidence which is available at present from controlled experiments suggests that impurities in the superphosphate (Walkley[10]; Oertel and Stace[2]) are at least not wholly responsible for the effects observed.

The continued persistence of the later-flowering varieties of subterranean clover where trace element deficiencies have been corrected, and particularly after seasons of below-average rainfall, will be observed with interest.

Acknowledgment

These investigations have been made possible by the interest and ready assistance of Mr. J. T. Summers, of Keith, and of Mr. W. E. Hansen, "Waljena," Keith, South Australia. It is a pleasure to acknowledge their co-operation.

Summary

Differences have been observed in the behaviour of the Dwalganup and later-flowering varieties of subterranean clover grown on some of the sandy soils in the Ninety-mile Plain in South Australia.

The Bacchus Marsh variety is highly productive when zinc, copper and limited quantities of superphosphate are applied to the soil, while under the same conditions the Dwalganup variety may remain quite unproductive.

On the other hand, the Dwalganup variety may be persistent, but unthrifty, under conditions where the Bacchus Marsh variety fails on account of zinc and copper deficiency.

Preliminary observations suggest that satisfactory development of the Dwalganup variety on some of these poor soils depends upon the addition of exceptionally heavy dressings of superphosphate, as well as zinc and copper. Evidence which is available at present suggests that impurities in the superphosphate are not responsible for the effects observed.

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SOME OBSERVATIONS AND EXPERIMENTS CONCERNING THE ROLE OF MOLYBDENUM IN THE NUTRITION OF THE FLOWERING PLANT

By R. D. WILSON and E. J. WARING

The element molybdenum, though required in only trace amounts, is apparently essential for the growth of some, possibly all, green plants. The work of Arnon and Stout[3] left little doubt that molybdenum was an essential element in the nutrition of the tomato plant. Piper[10], in the case of oats, and more recently, Hewitt and Jones[6], in the case of tomato, cauliflower, cabbage, mustard and oats, found that when molybdenum was not supplied in water or sand cultures, normal growth was not obtained. There have been several reports in the literature, including those relating to whiptail of cauliflower[4, 8, 18] and that of Fricke[5] on the blue chaff disease of oats, indicating that application of compounds containing molybdenum either improves the growth of plants or prevents the development of an abnormal condition.

Anderson and Thomas[1] concluded from the results of a study on the relation of molybdenum to an improvement in the growth of certain legumes that the favourable responses appeared to be entirely due to the effect of this element on symbiotic nitrogen fixation by the root nodule bacteria. Steinberg[11] found that the addition of trace amounts of molybdenum improved the growth of the fungus *Aspergillus niger* when the nitrogen source consisted of nitrates, but not when nitrogen was supplied in the form of ammonium compounds. He suggested that molybdenum was essential for activation of nitrate reductase in the reduction of nitrates to ammonium for the synthesis of amino acid and protein. Arnon[2], on the other hand, in the case of barley plants grown in nutrient solution, obtained a considerable increase in the dry weight of the plants by the addition of small amounts of molybdenum when ammonium compounds were the nitrogen source but not when nitrogen was supplied in the form of nitrates. Hewitt and Jones[6] found that molybdenum-deficient plants had an appreciably higher nitrate content than plants supplied with molybdenum, thus tending to confirm the theory of Steinberg[11] that molybdenum acts as a catalyst in nitrate reduction. Millikan[7] has presented evidence to show that, in the case of flax, small amounts of ammonium molybdate would alleviate the toxicity symptoms produced by excessive quantities of soluble salts of manganese, zinc, copper, nickel or cobalt.

It had been known from field observations that large applications of nitrogenous fertilizers tended to induce a greater amount of whiptail in cauliflower (*Brassica oleracea* var. *botrytis L.*) crops and it was suspected that the role of molybdenum in relation to whiptail might be concerned with the reduction of nitrates in the plant, especially in view of the findings of Steinberg[11]. (The work of Hewitt and Jones[6] and that of Arnon[2] was not seen by the writers until the completion of the experiments described

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in this paper.) Tests were therefore carried out on cauliflower leaves, using one per cent. diphenylamine in concentrated sulphuric acid, a reagent which has been recommended by Thornton *et al*[12] for testing for the presence of nitrates in plant tissue, and which gives a blue or violet colour in the presence of nitrates.

Methods

Tests have been carried out in the field on leaves of plants which had been treated with either sodium molybdate or ammonium molybdate at rates of from 0.025 to 0.2 grams of these materials per plant (quantities approximately equivalent to rates of $\frac{1}{4}$ lb. to 2 lb. per acre for the usual spacing in commercial cauliflower crops in New South Wales) and on leaves from untreated plants. In the case of midrib tissue, small pieces have been cut out and placed in a test tube and a small quantity (usually from 2 to 5 ml.) of one per cent. diphenylamine in sulphuric acid added. In the case of leaf tissue, it has been found convenient to use a cork borer having a diameter of 8 mm., cutting down through the leaf on to a rubber cork held on the lower side of the leaf, particularly where it is desired to secure intervenal leaf tissue without any of the main veins. One 8 mm. diameter disc of leaf material to about 2 ml. of test reagent has been found satisfactory. About one minute is required for each test. In order to reduce the possibility of accidents, when carrying the highly corrosive reagent on field work, the diphenylamine-sulphuric acid has been kept in a small glass-stoppered bottle packed in cotton wool inside a larger screw-top jar.

Where, as indicated below, plants have been treated with sodium molybdate or ammonium molybdate, the material has been applied as an aqueous solution to the ground at the base of each plant. In most cases 60 ml. of solution has been applied per plant, the strength of the solution ranging from 1 in 300 (0.2 grams per plant) to 1 in 2,400 (0.025 grams per plant).

Results

In tests which the writers have carried out during April, May and June, 1948, in the Windsor, Richmond and Sydney Metropolitan areas with the diphenylamine-sulphuric acid reagent on cauliflower plants of the varieties Hawkesbury Solid White, Nugget, Phenomenal Four Months, Phenomenal Five Months and Phenomenal Six Months, the tissue of the midrib and of the larger veins has given a strong positive reaction (blue colour with the test reagent). This strong positive reaction of the midrib and larger veins has occurred irrespective of whether the plants were healthy or showing symptoms of whiptail or whether the plants had previously been treated with molybdenum materials or not. According to Thornton *et al*[12], positive tests such as this are indicative of an adequate or abundant nitrogen supply and, as a matter of fact, all crops investigated by the writers during the period mentioned had received applications of nitrogenous fertilizers.

In the case of leaves of a healthy dark green colour, the intervenal areas have in some hundreds of tests given either a negative test (no blue colour) or, occasionally, a faint blue colour. The dark green intervenal tissue of severely whiptailed leaves have also given only a slight positive reaction, but a strong positive test has been secured with the intervenal chlorotic leaf tissue of leaves showing a mottling and yellowing which the writers believe to be an early stage of the whiptail disease.

From field observations, the first noticeable stage of this condition (Figs. 1 and 2) appears to be that the leaves are a lighter green than normal between the main veins and particularly towards the margins of the leaves. The condition is first apparent on the youngest of the full-sized leaves and as these leaves become older, the intervenal leaf tissue may become quite yellow in colour with only a band of green colour immediately ad-

jacent to the midrib and veins. Sometimes there is a natural recovery of affected plants although even if a plant recovers and the leaves become a normal green colour, the inner younger leaves almost always develop a certain amount of tip burn followed by a whiptail condition.

This intervenal chlorosis which appears to be identical with that described by Parbery[9] as magnesium deficiency, is thought to be an early stage of the whiptail disease for the following reasons:

(1) Neither this intervenal chlorosis nor whiptail develops in plants which, in the early stages of growth, have been supplied with sodium molybdate or ammonium molybdate.

(2) Field recordings of individual plants throughout their growth have shown that plants manifesting this intervenal chlorosis in any but the mildest form invariably later develop symptoms of whiptail.

Photo by J. R. Rengger.

Figure 1.
Cauliflower leaves from a crop at Windsor, N.S.W., showing intervenal chlorosis, particularly on the edges. Leaf on left shows slight chlorosis on margin only. That on the right is more severely affected.

Thus it has been found in tests on leaf tissue from numerous cauliflower crops in the Central Coast area of New South Wales, that the only intervenal leaf tissue giving a strong positive reaction with diphenylamine-sulphuric acid has been from leaves showing a chlorotic mottling and occurring in crops not treated with sodium molybdate or ammonium molybdate. It has further been found that in the case of such leaves the reaction is strongly positive where the leaf tissue is chlorotic, whilst normal healthy green leaf tissue on the same leaf gives no reaction or only a faint blue colour.

After plants showing the intervenal chlorosis have been treated with an aqueous solution of sodium molybdate or ammonium molybdate at rates ranging from 0.025 to 0.2 grams per plant, it has been found in repeated tests that the intervenal chlorotic leaf tissue on the younger affected leaves ceases to give any blue colour with diphenylamine-sulphuric acid within 2½ to 5 days, whereas similar leaves on check untreated plants continue to give a strong reaction. In the case of older outer leaves showing much yellowing, the intervenal tissue has in some cases continued to give a positive reaction for up to four weeks after treatment. It has also been found that the disappearance of the nitrate or other oxidising materials from the leaf tissue has preceded the development of a healthy

Photo by J. R. Rengger.

Figure 2.
Intervenal chlorosis of cauliflower leaf from a crop at Fairfield, N.S.W.
Left: Chlorotic leaf. Right: Healthy leaf.

green colour which, in the case of slightly mottled leaves, normally develops in about five to seven days.

Discussion

The diphenylamine-sulphuric acid reagent gives the blue or violet colour of diphenylbenzidine violet with oxidising materials other than nitrates so that molybdenum may not be concerned entirely with the reduction of nitrates, although it would appear probable that the greater part of the oxidising materials present in the intervenal areas of the mottled leaves would be in the form of nitrate, especially in view of the field evidence that heavy applications of nitrogenous fertilizers induce a greater amount of this intervenal chlorosis. Nitrites will give a blue colour with the test reagent but tests carried out by the writers with alpha-naphthylamine and sulphanilic acid on aqueous extracts from all parts of both mottled and "whiptail" leaves have failed to show the presence of nitrite in any case. The observations and experiments reported above suggest that molybdenum acts as a catalyst in the reduction processes in the cauliflower plant, probably in the reduction of nitrates to ammonium compounds and amino acids. The work of Hewitt and Jones[6], in which all the major symptoms of the whiptail disease of cauliflower have been produced by sand culture technique in the laboratory, has also shown that molybdenum is concerned with nitrate reduction. The results are in accord with the findings of Steinberg[11] in reference to the utilization of nitrogenous materials by the fungus *Aspergillus niger*, but, in the light of present knowledge, appear to conflict with the results of Arnon[2] concerning the effect of molybdenum on the growth of barley plants in nutrient solution supplied with either nitrate or ammonium compounds as the source of nitrogen. Millikan[7] has drawn attention to a similarity between the symptoms of molybdenum deficiency and those of manganese toxicity and has inferred that the function of molybdenum in relation to whiptail of cauliflowers may be to counteract the effect of excess manganese. The writers have no experimental evidence to offer on this point at present. It is of interest, however, to note that Parbery[9] reported that manganese was present in greater amounts in cauliflowers grown on whiptail-liable soil than in plants grown on soil which produced healthy plants.

Symptoms produced by Hewitt and Jones[6] on cauliflower and cabbage have included an intervenal chlorosis and yellowing similar to that described above in the case of field crops in New South Wales. Parbery[9] observed the association between the intervenal chlorosis and whiptail but considered that the two symptoms were probably due to different causes. His evidence that the intervenal chlorosis was due to an inadequate supply of magnesium is not convincing.

The writers have not yet experimented with applications of sodium molybdate or ammonium molybdate at rates less than 0.025 grams per plant, although the work of Arnon and Stout[3], Piper[10] and Hewitt and Jones[6] in sand culture or water culture, would suggest that the amount of molybdenum required per plant is very much less than the minimum quantity used in these experiments. Arnon and Stout[3], for example, found that for young tomato plants the addition of 2 micrograms per plant was adequate to produce normal growth.

It may be mentioned here that the diphenylamine-sulphuric acid test on intervenal tissue of mottled leaves has proved of considerable practical value both in checking the effectiveness of various molybdenum treatments as well as in assisting in the diagnosis of the early stages of whiptail in commercial crops.

Summary

(1) An intervenal chlorosis of cauliflower leaves which is thought to be an early stage of the whiptail disease, is described.

(2) Tests on the intervenal chlorotic tissue of such leaves with diphenylamine-sulphuric acid have given a strong positive reaction whereas healthy green intervenal tissue has given no blue colour or only a very faint positive reaction.

(3) Treatment in the field of plants having leaves showing this intervenal chlorosis with sodium molybdate or ammonium molybdate at rates of 0.025 to 0.2 grams of these materials per plant has resulted in the disappearance of the oxidising materials (as determined by the diphenylamine-sulphuric acid test) from the intervenal areas within $2\frac{1}{2}$ to 5 days in the case of the younger chlorotic leaves.

(4) The disappearance of oxidising materials from the leaves of treated plants has preceded the formation of a healthy dark green colour which, in the case of the younger leaves, has occurred in about 5 to 7 days.

(5) It would appear that molybdenum acts as a catalyst in the reduction processes of the cauliflower plant, probably in the reduction of nitrates.

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THE INHIBITION OF SUCKERING IN TOBACCO BY CHEMICALS

The synthetic growth regulating compounds now cover a wide field of application. According to the concentration and type of compound, it is common to find them being effectively used as herbicides, to control fruit fall, to prolong dormancy and to stimulate root growth. In addition to these types of result where the effect is caused by bringing the growth regulating substance into contact with the plant or plant part concerned, other workers have demonstrated telemorphic effects, where pronounced morphological responses are induced at some distance from the point of application of the substance. These responses include the retardation in the development of axillary shoots and young leaf primordia. Beal[1], working with decapitated Red Kidney beans retarded the development of axillary shoots by treating the cut ends with certain substituted phenoxy compounds. This technique was applied to tobacco by Steinberg[2] who found that some of the growth regulating compounds used stimulated the axillary growth and others retarded it.

This type of result holds some promise of a practical application in the tobacco growing industry. In the commercial production of tobacco, the plants are "topped", that is, the flowering heads are cut off. This operation has the effect of stimulating the development of shoots from the axillary buds. This new axillary growth, if allowed to develop, would decrease the yield and lower the quality of the commercial leaf. It has to be removed from the plant, an operation known as "suckering", at intervals up to the final harvest. The suckering of tobacco is time consuming, and if it could be reduced or eliminated production costs would be lowered. With this in mind, the reactions of four esters of 2.4 dichlorphenoxyacetic acid on the development of axillary growth in tobacco, have been observed.

The tobacco plants were grown in pots, one plant per pot. The main stems of all plants were defoliated and then topped to leave a constant number of potentially active axillary buds. The stumps of one-half of these plants were treated with the growth regulating compounds, the other half acted as controls. Lanoline, which when used by itself, induced no response in the treated plants, was used as a carrier for the esters. The cut stumps of all the treated plants became swollen within 3-4 days of the application of the chemical, and turned a yellowish-green colour, then later brown. In this series, as in others, as growth proceeded, there was a visible difference in axillary growth between the chemically treated plants and their respective controls.

The plants were cut off at the soil surface forty-two days after treatment and the main stem, and axillary growth weights determined. The results are summarised in the table where the axillary growth is given as a per cent. of the total weight of the plant and as a ratio to the weight of the parent stem.

Treatment	Axillary growth weight as per cent. of total weight.		Ratio of Axillary growth weight to weight of parent stem.	
	Treated	Not Treated	Treated	Not Treated
Methyl ester ..	46.40	79.10	0.9	3.8
Ethyl ester ..	55.68	81.85	1.3	4.5
N. Propyl ester	59.02	71.94	1.4	2.6
N. Butyl ester	52.80	68.30	1.6	2.2
Lanoline	59.41	61.85	1.5	1.6

The figures are the average values for three plants and the evident differences between the treated and untreated plants indicate strong possibilities of the axillary growth being inhibited. Work is being continued on the physiological manifestations in the tobacco plant resulting from the action of these and other growth regulators.

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AUSTRALIA STILL FREE FROM TRUE GLADIOLUS SMUT

In 1944, Langdon and Herbert[1] reported that "Gladiolus Smut," due to *Urocystis gladioli* (Requien) W.G.Sm., had been found in Queensland, and stated that it was probably widespread in Australia.

Recently Dr. Sasscer, Officer-in-charge, Division of Foreign Plant Quarantine in the United States Department of Agriculture, in a letter to the undersigned, stated that the American record of this disease had recently been shown to be erroneous, but that the true "Gladiolus Smut" had been intercepted in a shipment of gladioli from the Netherlands. He requested the co-operation of this Department in checking the above record and in furnishing full information regarding the occurrence and distribution of the Smut in Australia, so that appropriate quarantine safeguards could be put into operation against gladioli being shipped from Australia to U.S.A.

Dr. Herbert, who made the original determination of the fungus as *Urocystis gladioli* in 1943, based the identification on characters ascribed to English specimens. In view of the fact that the collection on which the American record of *Urocystis gladioli* was based was shown to be *Papulospora gladioli*, the Queensland material was re-examined by Dr. Herbert and Mr. J. H. Simmonds. It was found to be neither of these species, but a *Moniliaceous Deuteromycete*, the "spore balls" being conidial heads left after the disappearance of the hyphae.

Plant Pathologists in each of the States and in C.S.I.R. have carefully checked their records and are confident that the disease "Gladiolus Smut," due to *Urocystis Gladioli*, is not present in Australia.

The official position, therefore, is that Australia is still free from the true "Gladious Smut" and care is being exercised under quarantine to maintain this position.

T. H. HARRISON.
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Department of Health,
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(*Received for publication, 2nd April*, 1948.)

LETTERS

TOO OLD AT THIRTY?

We must all have met the belief that a man's best research work is done before the age of thirty. Some authorities hold this belief so strongly that they recommend that men should cease research at thirty or thirty-five and take up administrative work. I am not concerned here with the problem of where administrators of scientific work should come from, or with asking whether originality may not be as important in administration as in research; I am simply concerned with whether or not the belief is based on fact.

The question is easily answered by a statistical study. Adams, in a little-read journal which yet contains much of general interest to scientists[1], shows that the belief is little more than a superstition. His method is to determine the age at which the man's chief work was done; he calls this age the Prime. He has determined the primes of 4,204 scientists over the last 350 years, including most of the well-known names, and finds that the median value of the prime remains constant through the centuries at 43, while primes under 30 number only nine per cent. of the whole.

Adams' method contains a bias in favour of early primes. Some brilliant workers have died young; Galois, who made great advances in algebra, and Moseley, who discovered atomic numbers, met violent deaths in their youth. Others again have turned to other occupations, so should probably not be used for this study. Adams has, however, included all these in his calculations. On the other hand, some of his octogenarians were distinguished for assemblages of facts rather than discoveries; it seems fair to include such summaries as "research," though Adams introduces a bias in favour of old age by choosing the date of the last of a series of publications, rather than that of the middle member. These difficulties, which he discusses frankly, are of minor importance.

Youth has the advantage of intuition (which could later be blunted by orthodox teaching), while maturer years have the advantage of wider knowledge. Accordingly, it is not surprising to find that among the sciences, the youngest median prime is in mathematics at 37, while the older primes are in biology.

Adams points out that age is only one of many factors. "Health, leisure, apparatus, stimulus may concur only at one random period of life. . . All these limiting factors seem so obvious that a statistical enquiry would seem unnecessary were it not for such statements as those which head this paper." Adams begins his paper with quoting the opinions of Ostwald and Einstein on the opposing side. He has no difficulty in disposing of them. Perhaps the best comment on the discussion is the Latin proverb; "Those whom the gods love stay young till they die."

G. W. LEEPER.
University of Melbourne.

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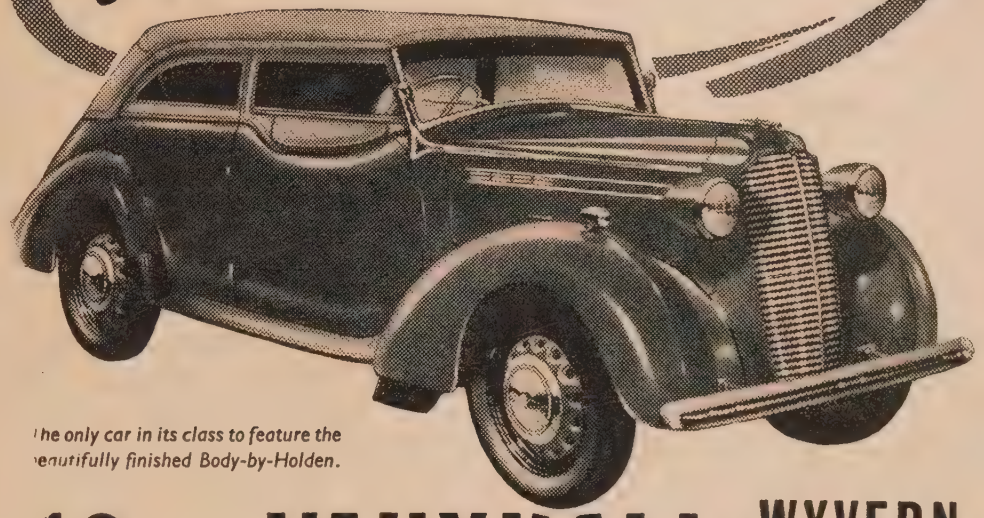

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JOURNALISM IN AGRICULTURE

By F. S. CRAWFORD

The newspaper, especially the specialist farming newspaper, is an important aspect of agricultural extension. As yet it is not being used to full advantage by official sources. Although wireless is an excellent medium for spreading the "gospel" its influence necessarily is restricted. The printed word is more effective and is continually being sought by both rural and urban population to supplement information obtained over the air. It is significant that agricultural progress has been slowest in those countries not well served by their newspapers.

Extension workers know that farmers as a group are conservative and slow to make a change. There is also a wide range in ability between the poorest and the best farmer in any region. Even the simplest truths have had to be stated and re-stated many times before they have been adopted generally. It is here that the agricultural newspaper has fulfilled one of its most useful functions.

Farming newspapers serve as media for passing on local expert information. They are also in a position to direct attention to scientific developments in other parts of the world that are of interest to farmers generally. Because the farming paper includes many other features of common appeal and interest it is a more effective medium in making contact with rural areas than are specialist journals.

In recent years rural papers have recognised the need and value of expert agricultural assistance by appointing trained agriculturists to their staffs. The principle might well be adopted by the dailies as soon as there is sufficient newsprint available for them to give a wider news cover and an opportunity to give agricultural topics the same specialised attention as that given say, to the Sporting and Financial columns today.

It was emphasised that if agricultural news is to be effective it should be up to date and readable. There is a technique in journalism and matter has to be attractively presented if it is to be read widely.

The essential difference between a departmental officer and an agricultural writer for the popular press is one of approach, and the scientifically trained man to take up journalism must adapt his language and his thinking to his public. Technical terms must give way to a mode of expression that will convey to the layman as true and precise a statement of any problem as is possible in colloquial language.

Broadly speaking, the daily newspaper concentrates on "highlights" and by eliminating detail and explanations gives an interesting but an incomplete picture of a development or discovery. In the weekly or monthly paper a greater degree of accuracy and explanatory detail is expected. But at all times matter should be treated simply and intelligently.

Reference was made to the various types of errors (irritating to the agricultural fraternity) that appear in the popular rural press from time to time. It was suggested that some, at least, were likely to

(From the Presidential Address, delivered to the Melbourne University Agricultural Society, on 9th April, 1948.)

keep on occurring until papers employed men who knew both agriculture and journalism. It was impossible for a paper to give an adequate agricultural service to its readers without having on its staff more trained agricultural journalists.

Official sources should co-operate more closely with agricultural newspapers and especially where trained agriculturists were on the staff. Papers had a penetrative power not available to official journals because of the wide service they give to readers and the confidential manner in which correspondence is treated and information supplied. Criticism is levelled at the form of some official reports issued to the press. It is common practice when such reports are received in a newspaper office to turn to the last page to find the "newsy" piece with which to begin the story in the popular press for popular consumption. Sometimes it is the name of a crop competition winner, sometimes the main agricultural lesson that has come out of the contest. In all cases the lead to the story should contain the salient feature or features of the whole story. It is a clear-cut invitation to the reader to read it.

SHY BEARING DUE TO COREID BUGS?

By J. H. SMITH

Faulty setting on a scale which makes crop production unprofitable is illustrated by the common experience with coconuts in the Solomons and some other Pacific Islands, where commercial plantings often fail to mature a crop. Detailed entomological investigation prior to the war had led to the conclusion that *Amblypelta coccophaga* was the cause but no satisfactory control was worked out.

Two very closely related bugs are present in Queensland; one, the fruit-spotting bug *A. lutescens*, was originally recorded as a pest of bananas, although perhaps better known as a trouble in papaws, particularly in central and northern Queensland. It feeds on many plants but it has not hitherto been considered an important cause of faulty production in tropical and sub-tropical fruits.

The initial query came from Bundaberg where custard apples usually carry negligible crops, even though the trees are vigorous and the flowering normal. The same phenomenon was observed at Maryborough. Insects were suspected but the only species collected was the fruit-spotting bug and it was difficult to find. Recently the same thing has happened in Queensland nuts, when vigorous trees flower and set fruit normally and then commence shedding the fruit until no crop remains. The shed nuts show no external signs of damage and physiological shedding would be the most natural diagnosis. However, sectioning of the nuts showed a jellied kernel which is apparently always associated with bug shedding. This core was linked with a small lesion on the testa by a discoloured line made by the beak of a sucking insect. There was no doubt that the few *A. lutescens* present on the trees were responsible for the shedding. At the present time it is known that the bug can be responsible for almost complete failure in the Queensland nut and that crops of this nut generally are far below the apparent potential bearing capacity of the plants. Entomologists hazard a guess that shy-bearing habits in many trees will be traced to this bug or related pests.

(Specimens of a Coreid bug, which are frequently concerned in the shedding of young fruit, were exhibited at the March meeting of the Queensland Branch by Mr. J. H. Smith.)

COUNCIL PROCEEDINGS

A meeting of Council was held at the University Club, Sydney, on Tuesday, 3rd August, 1948.

Present:

The Hon. General Secretary (Mr. L. F. Mandelson), Professor J. R. A. McMillan (A.C.T.), Dr. E. T. Edwards (N.S.W.), Messrs. J. M. Vincent (Qld.), G. de Vahl Davis (S.A.), R. H. Hayman (Vic.) and E. J. Breakwell (W.A.). Apologies were received from the President (A. F. Bell), the Hon. General Treasurer (F. C. McCleery) and Mr. R. H. Anderson (Tas.)

In the absence of the President Dr. E. T. Edwards occupied the Chair.

Award of Merit:

Council decided that nominations should be called immediately for the Medal, which is to be presented at the 13th General Meeting. Nominations are to close with the Hon. General Secretary on Friday, 1st October, 1948.

Interchange of Personnel:

The following resolution was adopted:

"The Australian Institute of Agricultural Science considers that—

(a) the matter of interchange of Personnel, particularly in Government and semi-Government employment, is still unsatisfactory;

(b) this policy is directly opposed to agricultural progress and national welfare of Australia;

(c) it is directly opposed to freedom of choice of employer by individuals;

and therefore requests all Government and semi-Government organisations to adopt the following:—

"That when a person applies for a position with a Government or semi-Government organisation such organisation shall not confer directly or indirectly with the applicant's employer (including a Government or semi-Government organisation) to ascertain

(a) whether or not the employer wishes to retain the services of the applicant, or

(b) of the effect of the proposed transfer of the applicant and further that should information of this nature be available to proposed employer, the latter shall disregard it in making his choice."

Sub-Committee on Review of Articles of Association:

In response to a questionnaire and report circulated to the various State Branches, the following decisions resulted:—

1. The Institute does not desire to exclude non-graduates from Corporate membership in the future. Queensland and Western Australia dissented from this view.
2. It is not desired to create an associate membership with limited privileges for non-graduates. Victoria and Western Australia dissented.

Qualifications Committee:

"That the resignation of Associate Professor G. W. Leeper from the Qualifications Committee, be accepted with regret, and that Mr. G. H. Vasey be appointed to the vacancy."

Membership:

Having received the recommendation of the Branch submitting the application and of the Qualifications Committee, the following were admitted to Corporate Membership:—

Carne, P. B. (A.C.T.).
Crawford, A. J. (N.S.W.).

Jessup, J. E. (N.S.W.).
Johnson, R. I. (N.S.W.).
Kelly, C. R. (Vic.).
Powrie, J. K. (S.A.).
Lea, H. W. (N.S.W.).
Martyn, E. J. (Tas.).
Orr, J. S. (Vic.).
Paton, D. F. (Tas.).
Potter, J. C. (S.A.).
Sleeman, J. R. (A.C.T.).
Young, P. J. (S.A.).

and to Student Membership:—

Atkins, B. F. (N.S.W.).
Avent, K. L. (Vic.).
Barley, K. P. J. (Vic.).
Bird, A. R. (Qld.).
Berryman, J. W. (Vic.).
Buckley, K. S. (N.S.W.).
Crofts, F. C. (N.S.W.).
Churchward, H. M. (N.S.W.).
Cranston, J. S. (N.S.W.).
Doolette, J. B. (S.A.).
Dunk, W. P. (Vic.).
Edwards, Miss C. E. (Vic.).
Edwards, D. M. (N.S.W.).
Jackson, D. L. (N.S.W.).
Jenkins, P. T. (Vic.).
Littler, J. W. (Qld.).
Mackey, B. E. (N.S.W.).
McBride, G. (S.A.).
Nicolson, L. N. (S.A.).
Possingham, J. V. (S.A.).
Pulsford, D. J. (N.S.W.).
Ryan, J. W. (S.A.).
Symon, D. E. (S.A.).
Wells, C. B. (S.A.).
Weymouth, P. K. (Vic.).
Wright, W. E. (N.S.W.).
Yahya, M. (S.A.).

Dr. J. G. Bald's resignation was accepted with regret.

The following *transfers* were noted:—

E. W. B. Da Costa—Qld. to Vic.
B. Horowitz—N.S.W. to Vic.
P. McGowan—Vic. to Tas.

NOTICE OF GENERAL MEETING

The Thirteenth Annual General Meeting of the Institute will be held at Hobart, on Monday, 10th and Tuesday, 11th January, 1949, that is immediately prior to the meetings of the Australian and New Zealand Association for the Advancement of Science.

This meeting will include the business of a regular General Meeting as well as the presentation of formal reports, discussions on Institute Affairs, Election of President and the Award of the Australian Medal of Agricultural Science.

L. F. MANDELSON
Hon. General Secretary.

BRANCH NOTES

AUSTRALIAN CAPITAL TERRITORY

The 72nd General Meeting of the A.C.T. Branch was held on July 15, 1948, when an address entitled "Dairying in Australia," was delivered by Mr. Headley Clark. Mr. Clark began by reviewing the history of the dairying industry, its importance in the development of Australia and its present importance to our local and overseas trade and economic position.

The speaker reviewed the development of co-operation among the dairy farmers, and the importance of these bodies during wartime when the marketing of dairy produce was taken over by the Government.

A survey of costs of production carried out by the industry was followed by the appointment of the Joint Dairying Industry Advisory Committee which set about ascertaining the costs of production on typical farms and relating these costs to market and farm conditions.

The costs survey was to be spread over five years, and the initial survey was conducted. As a result of this the Government fixed the price of butter at two shillings a pound with provision for review each year. In addition, the Government allocated £1,250,000 to be spread over five years for improvements to the industry.

Mr. Clark then discussed Australia's production in relation to present and future consumption and export rates. He emphasised the difficulties of schemes of improvement of the industry, and the need for educational and psychological approaches to the problem. He concluded by stating that the problem was one of individual districts and that no one plan would suffice for the whole industry.

NEW SOUTH WALES

A general meeting ot the N.S.W. Branch was held on July 30, 1948. The main business was an address by Mr. G. V. Lawrence, organizing secretary of the Murray Valley Development League. The address, which was illustrated by film strips, and a beautiful colour film of the Murray Valley, will form the subject of an article in a forthcoming issue of the Journal. Representatives of the Minister for Agriculture, Geographical Society, Economics' Society, Forestry Commission, Murrumbidgee Water Users' Association, Rural Bank, Bank of N.S.W. and the Press. were present.

M.I.A. Sub-Branch

The annual general meeting of the M.I.A. Sub-branch was held at the C.S.I.R. Irrigation Research Station, Griffith, on June 2, 1948.

The following office-bearers were elected for the ensuing year:—

President: Mr. N. G. Cassidy.

Deputy President: Mr. W. Jones.

Hon. Secretary-Treasurer: Mr. D. V. Walters.

Committee Members: Messrs. H. N. England and L. F. Myers.

The Presidential Address was given by Mr. N. G. Cassidy, who spoke on "Sugar —From Farm to Factory."

QUEENSLAND

At the meeting of the Queensland Branch held on June 16, 1948, Mr. A. P. Dodd, of the Biological Section, Queensland Department of Lands, gave an address on recent developments in the control of noxious weeds in Queensland.

Mr. J. L. Clayton, a mill technologist of the Bureau of Sugar Experiment Stations, who recently returned from a visit to Hawaii, addressed an ordinary general meeting of the Branch on July 28, 1948. His subject was "Sugar Culture in Hawaii."

SOUTH AUSTRALIA

At a general meeting held on May 28, 1948, four films were shown:—

(1) "Irrigation in South Australia." Prior to the showing of this film Mr. A. C. Gordon outlined the history of irrigation in that State and gave a commentary during the showing of the film.

(2) "Whyalla Main."

(3) "Water to the North."

Lt. Col. H. G. Tolley introduced the two films on the Whyalla pipeline with a brief account of the construction of the pipe line.

(4) "Tjurunga." A talkie film on the Aborigines of Central Australia.

At the general meeting held on July 23, 1948, Mr. D. S. Riceman, of the Division of Biochemistry and General Nutrition, C.S.I.R., who has recently returned from abroad, gave an illustrated address on "Some of the fundamental work in plant nutrition carried out at the University of California (Berkley), under the direction of Professor D. R. Hoagland.

TASMANIA

During the past few months the Branch has been strengthened by the addition of three new members, Mr. E. J. Martyn, of the Entomology Division of the Department of Agriculture; Mr. D. F. Paton, who has recently joined the Agronomy Division and is stationed in Launceston, and, by transfer from the Victorian Branch, Mr. P. McGowan.

General meetings were held on May 27, July 1, and August 2.

At the May meeting, Dr. Dickson gave a talk on the main activities of the Division of Plant Industry and how these had been assisted by the co-operation of the State Departments of Agriculture. Special interest was aroused in the problems and objectives of pasture development in Northern Territory. A short address was then given by Mr. R. M. Moore on weeds and more recent advances made in methods of control.

Visitors welcomed to the July meeting were Mr. D. B. Adam, of the Waite Insti-

tute, Dr. Barnard and Miss J. B. Grace, of C.S.I.R., and Mr. A. G. Strickland, of the South Australian Department of Agriculture. Mr. Adam gave a talk, illustrated by lantern slides, on the general problem of "Gummosis" and "Dieback" in apricots and the present position in regard to research. Miss Grace then discussed the plan and progress of the orchard survey in the different centres. A general discussion on the aspects and possible lines of future work followed.

The speaker at the August meeting was Mr. A. H. Crane, Chief Commissioner of Forests. In his address, Mr. Crane reviewed the timber resources of Tasmania and ways by which export could be increased and economic regeneration, particularly of Eucalypts, maintained. Some stands of timber here are amongst the heaviest in the world and this land should be used primarily for forests.

WESTERN AUSTRALIA

On June 25, a general meeting was held which consisted of the presentation of a symposium entitled "Some Aspects of subterranean clover in South-West Agriculture."

The subject being one of great topical interest and importance, attracted a large number of members and following upon the presentation of the various papers, questions were invited from the members and dealt with by the appropriate speaker. Summaries of the papers will be found on page 119.

GENERAL

A.N.Z.A.A.S. — HOBART MEETING

The forthcoming meeting of the Australian and New Zealand Association for the Advancement of Science, will be held in Hobart from 12th to 19th January, 1949.

The itemized Agenda is not yet available. This information, together with details of place and times of meeting, will be circulated to members in ample time for them to make necessary arrangements.

There will now be two simultaneous programmes throughout Section K sessions—one for papers principally devoted to Agriculture and one for Forestry. By this means the position in regard to time has been considerably relieved, but, nevertheless, some concurrent agricultural sessions are anticipated so that late papers of special interest may be included.

As regards the accommodation available to the different sections, the University of Tasmania is at the present time in the process of changing over to the new building site on the old rifle range at Sandy Bay.

It has been found possible to group Sections K (Agriculture and Forestry); Section L (Veterinary Science) and Section M (Botany) together at Sandy Bay, thus facilitating the various joint sessions which have been arranged between these sections. The only joint sessions with Section K located elsewhere are those originated by Section G (Economics) and to be held at the old buildings.

The annual General Meeting of the Institute to take place prior to the commencement of the A.N.Z.A.A.S. programme will be held in the Physics lecture theatre, Sandy Bay, on Monday, the 10th January, and will be followed by a dinner at Wrest Point Riviera Hotel, arranged by the Tasmanian Branch for visiting members.

Arrangements for accommodation are in the hands of Mr. S. Warren Carey, Local Hon. Secretary for Tasmania for A.N.Z.A.A.S., C/o University of Tasmania, Box 647C, G.P.O., Hobart.

RETIREMENT OF MR. R. E. SOUTTER

Coincident with the appearance in June of the William J. Farrer commemorative postage stamp was the retirement from the Queensland Department of Agriculture and Stock of Richard E. Soutter, pioneer wheat breeder of the northern State.

Wheat growing is not a tremendous industry in Queensland, but of the 500,000 acres planted last season, 400,000 were under Soutter-bred varieties. Since many of his commercial varieties were produced in marginal wheat country far removed from the State's main wheat-growing districts, with inadequate staff and equipment and little in the way of subsidiary plots, Mr. Soutter's work as a plant breeder must rank with that of Australia's best. Certainly in his forty years of plant breeding he achieved outstanding success in crossing wheats for drought resistance, rust resistance and milling quality.

In his early days Mr. Soutter was in turn an assistant with the Queensland Acclimatisation Society, an agricultural college student, and horticulturist at Westbrook State Farm on the Darling Downs. Subsequently, he moved westwards to the Maranoa, supervising wheat variety trials in the marginal areas, and in 1906, was appointed Manager of the Roma State Farm, a position which he held until the station was closed in 1935.

Mr. Soutter has retired from active plant-breeding leaving an imposing array of important commercial varieties and a mass of potentially useful material. Should a Wheat Research Institute be formed in Queensland, its dedication to R. E. Soutter would meet with universal approval. —*C.W.W.*

AWARD OF FARRER MEMORIAL MEDAL

Professor J. A. Prescott has been awarded the Farrer Memorial Medal for 1948 for distinguished service to agriculture.

Professor Prescott has been Director of the Waite Agricultural Research Institute since 1938 and Professor of Agricultural Chemistry in the University of Adelaide since 1924.

From 1928 to 1947, as Chief of the Division of Soils of the C.S.I.R., he has been responsible for the development of soil surveys in Australia. The Soil Map of Australia, published by the C.S.I.R. in 1944, was the outcome of this work.

Professor Prescott was educated at the University of Manchester and after carrying out Research at Roshamstead and Leipzig, he was, in 1916, appointed Chief Chemist and later Field Superintendent to the Royal Agricultural Society of Egypt. He has been President of the Royal Society of South Australia, of the Australian Chemical Institute and of the Australian Institute of Agricultural Science. He was a member of the Scientific Goodwill Mission which visited India earlier this year.

PROFESSOR J. A. PRESCOTT

Obituary

LEO CHRISTIAN BARTELS

Members of the Institute will learn with profound regret of the sudden death on the 28th September of Mr. L. C. Bartels, Senior Agrostologist of the Victorian Department of Agriculture.

Born at Allendale near Ballarat in 1893, Leo Christian Bartels was educated at St. Patrick's College, Ballarat, and later at the Melbourne University, where he took the degree of Bachelor of Agricultural Science. Joining the staff of the Victorian Department of Agriculture in 1915, he conducted experimental work at the State Experiment Farm, Wyuna, for several years, and there developed a keen interest in irrigated agriculture.

In 1919 Mr. Bartels was placed in charge of the irrigated lucerne and pasture trials at the State Research Farm, Werribee, and the results of his work there greatly influenced the development of irrigation practices in this State. As Senior Irrigation Officer he was largely responsible for the successful establishment and development of pastures in the irrigation districts of Northern Victoria, and his work in that connection will be long remembered. In 1934 Mr. Bartels was appointed Senior Agrostologist of the Department of Agriculture, which office he held until his death.

He was a past President of the Melbourne University Agricultural Society and the Victorian Branch of this Institute, and was actively associated with many local organisations at Werribee. Widely known throughout the pasture districts of Victoria, Mr. Bartels was noted for his kindly nature and ready wit. In his passing, the State has lost a citizen who has served it well, and the Department an officer of great knowledge and experience.

PERSONAL

Mr. A. B. Hackwell, formerly Senior Agronomist in the Victorian Department of Agriculture, has been appointed to the staff of the C.S.I.R. Liaison Office at London.

Mr. T. C. Bell has resigned from the Developmental Division of Drug Houses of Australia to become Scientific Research Liaison Officer for the C.S.I.R. at Washington, U.S.A.

Mr. D. B. Williams, Rural Economist at Roseworthy Agricultural College, having been awarded the Pawlett scholarship from Sydney University and a Booth Fellowship from the University of Illinois, left for America at the end of July.

Mr. A. Pugsley, Geneticist at the Waite Institute, returned to Adelaide on September 17, after spending six months in America and attending conferences on plant breeding and genetics in Cambridge and Stockholm.

Mr. N. J. Flentje, of the Waite Institute, left for London at the end of August to study at the Imperial College of Science under a C.S.I.R. Studentship.

Mr. N. R. McKeown, of the Western Australian Department of Agriculture, has been appointed Lecturer in Agriculture and Agronomist at Roseworthy Agricultural College, South Australia.

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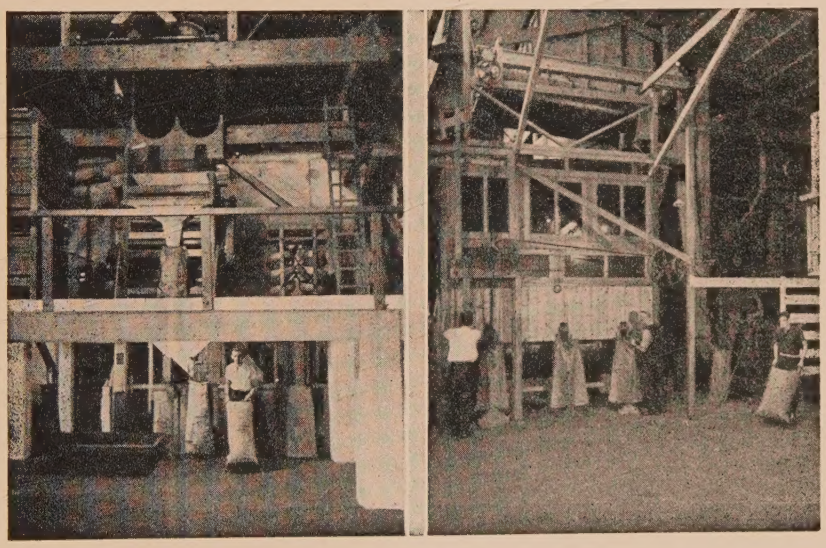

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